DAC&A

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No:	09/107,141
Applicant:	Karl S. Beers, et al.
Filed:	June 30, 1998
Title:	Multiple ASM OBIGGS with Different Permeability and Selectivity Membranes
TC/A.U.:	3644
Examiner:	John W. Eldred
Docket Number:	Serie 4572 (formerly 016499-546)

PETITION UNDER 37 C.F.R. § 1.137 REQUESTING REVIVAL OF UNINTENTIONALLY ABANDONED APPLICATION FOR PATENT

ATTENTION: OFFICE OF PETITIONS
Mail Stop Petition
Commissioner of Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

The above-identified application became abandoned for failure to timely file a proper reply to the Office letter mailed June 17, 2003. The Notice of Abandonment for this application is dated January 13, 2004.

Applicant hereby petitions for revival of this application as a timely response to the Office letter of June 17, 2003 was furnished to the US Patent and Trademark Office by Applicant on August 25, 2003. Attached here are copies of the returned, and USPTO stamped, post card, the Response filed on August 25, 2003, and the respective

Certificate of Mailing under 37 CFR 1.8(a). Also attached here is another complete copy of Applicant's US Patent File, as was originally requested on June 17, 2003.

The Commissioner is hereby authorized to charge the appropriate Petition Fee of $130.00 to Deposit Account No. 01-1375. The Commissioner is also hereby authorized to charge any additional fees which may be necessary to revive this application to Deposit Account No. 01-1375.

Respectfully submitted,

Linda K. Russell, Reg. No. 34,918

Date: April 14, 2004

VERIFIED STATEMENT

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Date: April 14, 2004

Linda K. Russell, Reg. No. 34,918

Air Liquide
2700 Post Oak Boulevard, Suite 1800
Houston, Texas 77056
Phone: (713) 624-8956

CERTIFICATE OF MAILING UNDER 37 CFR 1.8(a)

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Attention Office of Petitions, Mail Stop Petition, Commissioner of Patents, P. O. Box 1450, Alexandria, VA 22313-1450, on this 14 day of April, 2004.

Julie Turner

Office Action Summary	Application No.	Applicant(s)	
	09/107,141	BEERS ET AL	
	Examiner	Art Unit	
	J. Woodrow Eldred	3644	

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *31 December 2001* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-14,16-25 and 27-31* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-3, 11, 13, 14, 16, 17, 22, 24, 25, 29, and 30 are rejected under 35 U.S.C. 103(a) as being anticipated by Edwards et al in view of Ginsburgh et al.

Edwards et al disclose a system and method for inerting an aircraft fuel tank which comprises contacting a with a first membrane module with compressed air to produce a first nitrogen-enriched air stream which is introduced into the fuel tank during periods of low demand for nitrogen-enriched air and contacting a second membrane module with compressed air to produce a second nitrogen-enriched air stream which is introduced into the fuel tank during periods of high demand for nitrogen-enriched air, and in which the first membrane module has a lower O_2 permeance and a higher O_2/N_2 selectivity than the second membrane modules. See column 7, lines 30-44, which disclose that the permeator may comprise hollow fibers with different physical characteristics to produce different puritys level outputs. See especially column 10, line 61-column 12, line 18, and Figure 13 which disclose a system for inerting an aircraft fuel tank with two different membrane modules to produce two nitrogen-enriched air streams for use during different flight conditions. Edwards et al fail to show the nitrogen-enriched air stream introduced directly into the fuel. Ginsburgh et al teach that it is know to introduce inerting gas directly into the fuel in a fuel tank. See Figures 1 and 2. Motivation to combine is the clear advantage of more effecient mixing of the inerting gas and the fuel when the gas is introduced directly into the fuel. To employ the teachings of Ginsburgh et al on the fuel inherting system of

Edwards et al and have the inherting gas directly into the fuel is considered to have been obvious to one having ordinary skill in the art.

3. Claims 4, 5-10, 12, 15, 16, 18, 19-21, 23, 26-28, and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Edwards et al in view of Ginsburgh et al as applied above, and further in view of Dornheim.

Edwards et al disclose a system and method for inerting an aircraft fuel tank which comprises contacting a with a first membrane module with compressed air to produce a first nitrogen-enriched air stream which is introduced into the fuel tank during periods of low demand for nitrogen-enriched air and contacting a second membrane module with compressed air to produce a second nitrogen-enriched air stream which is introduced into the fuel tank during periods of high demand for nitrogen-enriched air, and in which the first membrane module has a lower O_2 permeance and a higher O_2/N_2 selectivity than the second membrane modules. See especially column 10, line 61-column 12, line 18, and Figure 13. Edwards et al fail to disclose the specific parameters of flow rates or establishing conditions to liberate a portion of O_2 dissolved in the fuel. Dornheim teaches, see the third paragraph from the end, that in a fuel tank inerting system conditions are created in which "oxygen enrichment occurs from the dissolved air in the fuel." To substitute particular parameters and conditions in the fuel inherting system of Edwards et al in place of unspecified conditions are considered to have been a matter of design and engineering choice in order to achieve the desired performance of the system in a particular situation. To have the claimed flow rates and oxygen liberation is considered, without any indication of unexpected results, to have been obvious to one having ordinary skill in the art.

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to J. Woodrow Eldred whose telephone number is (703) 306-4151.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 306-4177.

J. Woodrow Eldred

J. WOODROW ELDRED
PRIMARY EXAMINER
GROUP 220

Notice of References Cited

Application/Control No.	Applicant(s)/Patent Under Reexamination	
09/107,141	BEERS ET AL	
Examiner	Art Unit	Page 1 of 1
J. Woodrow Eldred	3644	

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
✓	A	US-6,293,525	09-2001	Ginsburgh et al	261/77
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Attachment for PTO 948 (Rev. 03/01, or earlier)
6/18/01

The below text replaces the pre-printed text under the heading, "Information on How to Effect Drawing Changes," on the back of the PTO-948 (Rev. 03/01, or earlier) form.

INFORMATION ON HOW TO EFFECT DRAWING CHANGES

1. Correction of Informalities -- 37 CFR 1.85

New corrected drawings must be filed with the changes incorporated therein Identifying indicia, if provided, should include the title of the invention, inventor's name, and application number, or docket number (if any) if an application number has not been assigned to the application. If this information is provided, it must be placed on the front of each sheet and centered within the top margin. If corrected drawings are required in a Notice of Allowability (PTOL-37), the new drawings MUST be filed within the THREE MONTH shortened statutory period set for reply in the Notice of Allowability. Extensions of time may NOT be obtained under the provisions of 37 CFR 1.136(a) or (b) for filing the corrected drawings after the mailing of a Notice of Allowability. The drawings should be filed as a separate paper with a transmittal letter addressed to the Official Draftsperson.

2. Corrections other than Informalities Noted by Draftsperson on form PTO-948.

All changes to the drawings, other than informalities noted by the Draftsperson, MUST be made in the same manner as above except that, normally, a highlighted (preferably red ink) sketch of the changes to be incorporated into the new drawings MUST be approved by the examiner before the application will be allowed. No changes will be permitted to be made, other than correction of informalities, unless the examiner has approved the proposed changes.

Timing of Corrections

Applicant is required to submit the drawing corrections within the time period set in the attached Office communication See 37 CFR 1.85(a)

Failure to take corrective action within the set period will result in ABANDONMENT of the application

06/01

US006293525B1

(12) **United States Patent**
Ginsburgh et al.

(10) **Patent No.: US 6,293,525 B1**
(45) **Date of Patent: Sep. 25, 2001**

(54) **ECONOMICAL APPARATUS FOR PRODUCING IMPROVED COMBUSTION AND SAFETY-ENHANCED FUEL**

(76) Inventors: **Irwin Ginsburgh**, 24125 Clearbank La., Newhall, CA (US) 91221; **Darrell Jay Metcalf**, 905 N. Oak Ave., Fillmore, CA (US) 93015; **Clyde LeRoy Tichenor**, 6470 LaCumbre Rd., Somis, CA (US) 93066

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/332,409**

(22) Filed: **Jun. 14, 1999**

Related U.S. Application Data

(60) Provisional application No. 60/089,376, filed on Jun. 15, 1998.

(51) **Int. Cl.**[7] **B01F 3/04**

(52) **U.S. Cl.** ..... **261/77**; 44/639; 220/88.3; 244/129.2; 244/135 R; 261/93; 261/119.1; 261/121.1; 261/123; 261/124; 261/DIG. 2

(58) **Field of Search** ..... 261/36.1, 77, 119.1, 261/72.1, 119.2, 123, 124, 72.2, 78.2, 93, 121.1, DIG. 2; 48/192; 44/639; 220/88.3; 244/129.2, 135 R

(56) **References Cited**

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6,136,267	*	10/2000	Bergman	244/135 R X
6,145,599	*	11/2000	Mumme	220/88.3 X

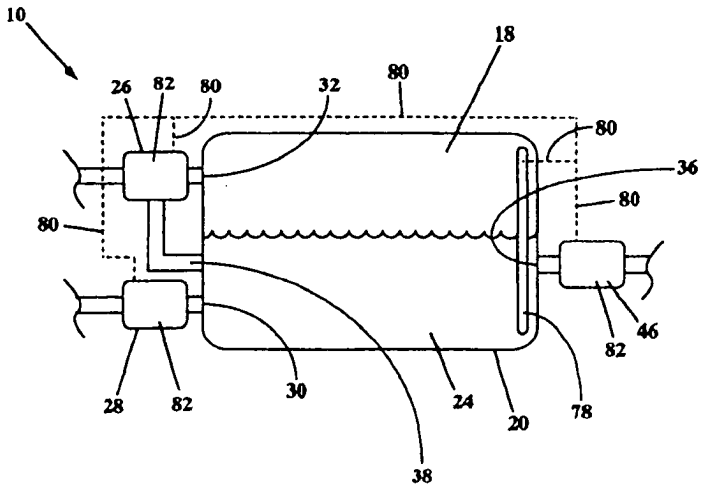
* cited by examiner

Primary Examiner—Richard L. Chiesa

(57) **ABSTRACT**

Apparatus for facilitating the mixing, absorption and/or retention of carbon dioxide 'CO2' in hydrocarbon fuel to economically produce a safety-enhanced and/or improved-combustion fuel. The apparatus includes at least one mixing receptacle having at least one coupling with a controllable inert gas supply; at least one coupling with a controllable hydrocarbon fuel supply; and at least one coupling with a CO2-enriched fuel fuel-line. The mixing receptacle(s) is configured to retain a volume of fuel and a volume of CO2 such that CO2-enriched fuel having a controllable gas-fuel ratio is the product of the mixing receptacle(s) and the gas of the ratio(s) exceeds 0.1 volume of CO2 per volume of fuel and is less than approximately 3 volumes per volume of fuel when conveyed from the receptacle(s). The apparatus controls the exposure of hydrocarbon fuel molecules to an optimal volume of CO2 within the receptacle(s). One embodiment of the invention includes the adaptation of the apparatus to existing fuel-burning devices, i.e. for retrofitting the apparatus thereto. The apparatus mixes and/or stores CO2 in the fuel to achieve one or more of the following benefits: fuel receptacle safety-enhancement; improved engine combustion; reduction in undesirable emissions such as soot particulate; reduction in fuel droplet size; and/or, reduced fuel viscosity.

24 Claims, 5 Drawing Sheets



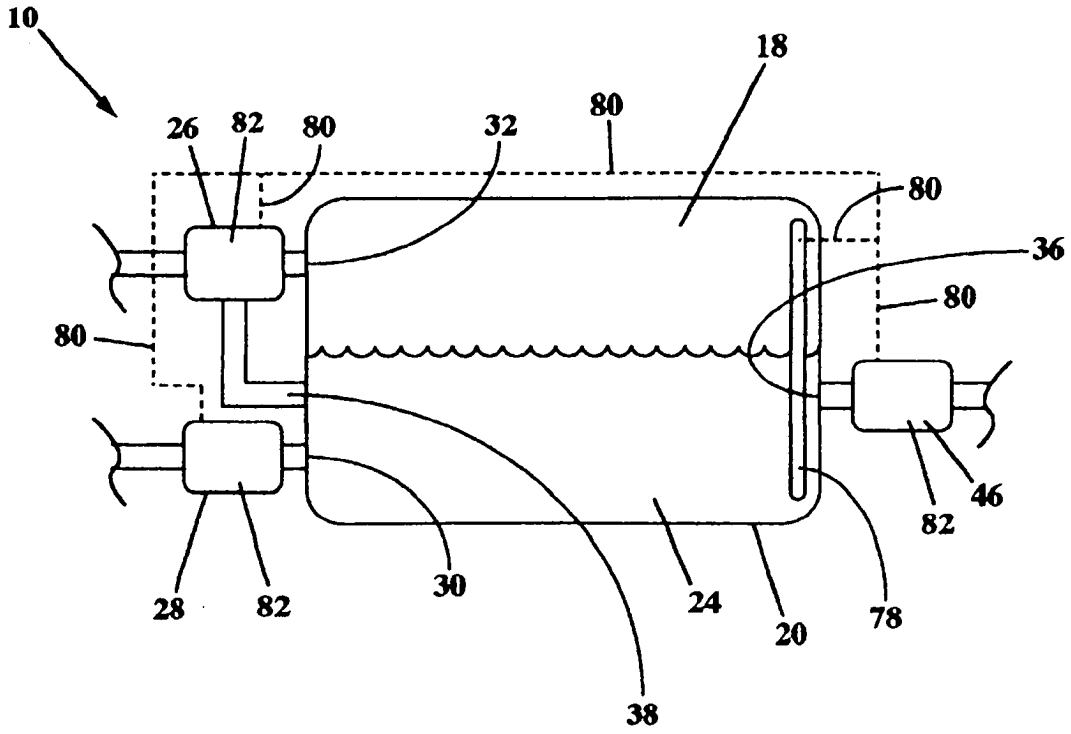

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FIG. 1

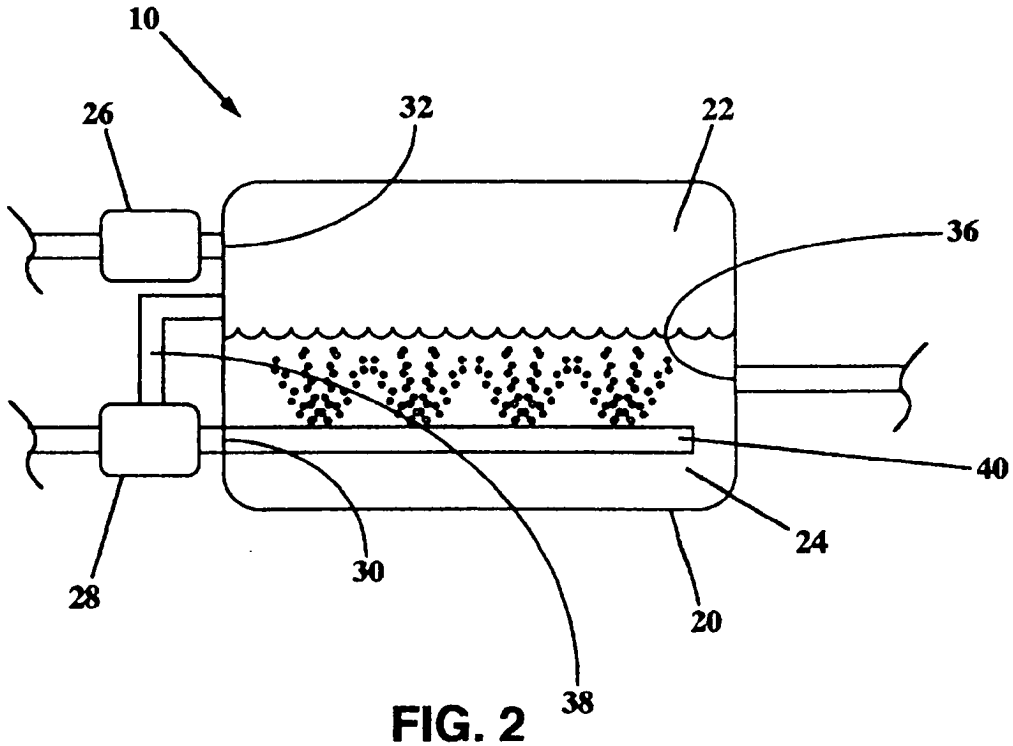
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FIG. 2

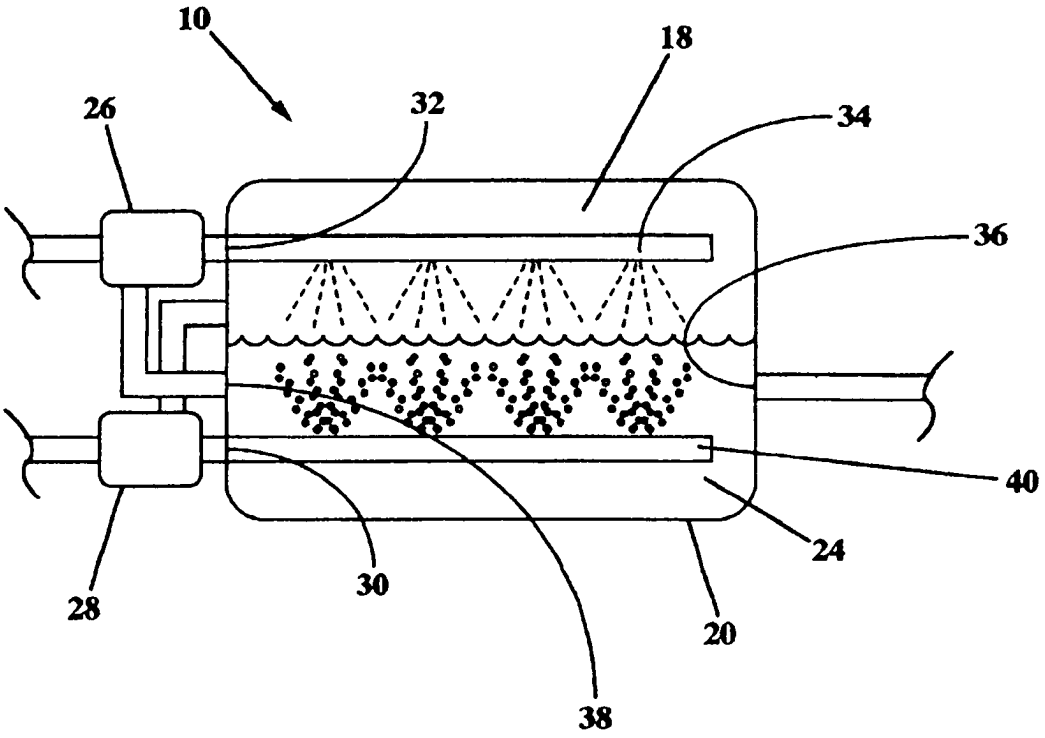

FIG. 3

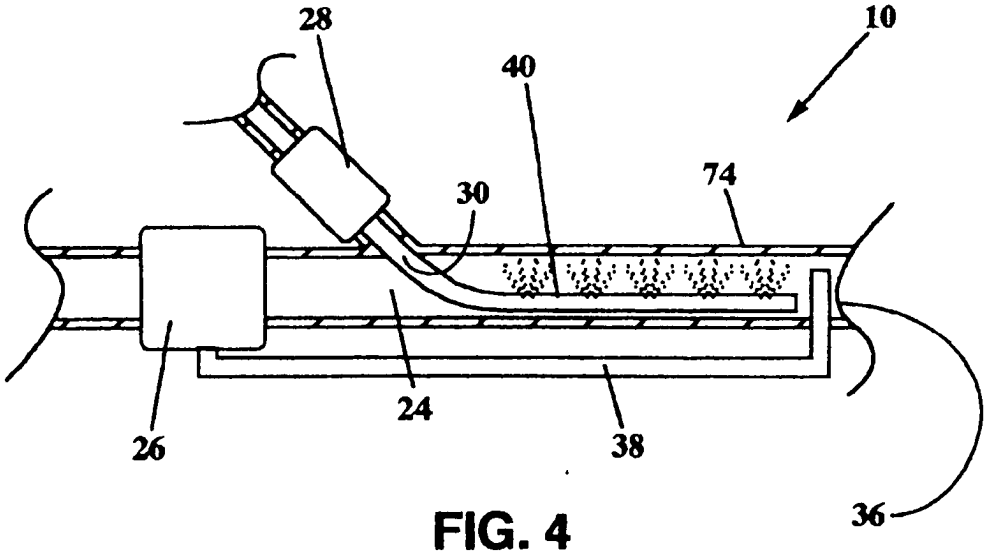

FIG. 4

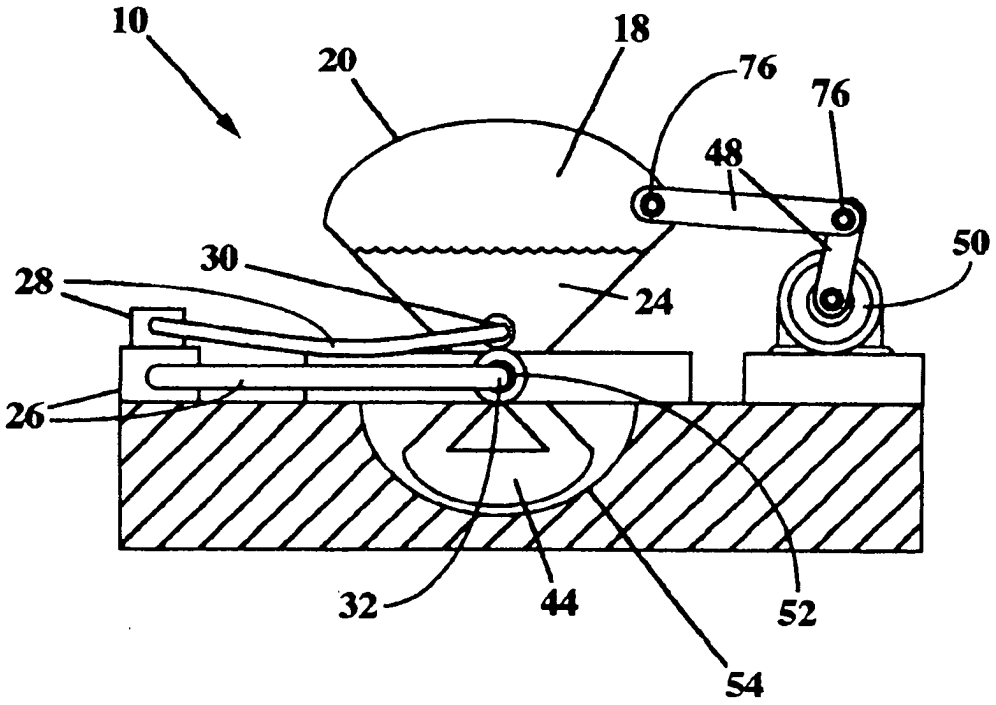

FIG. 5

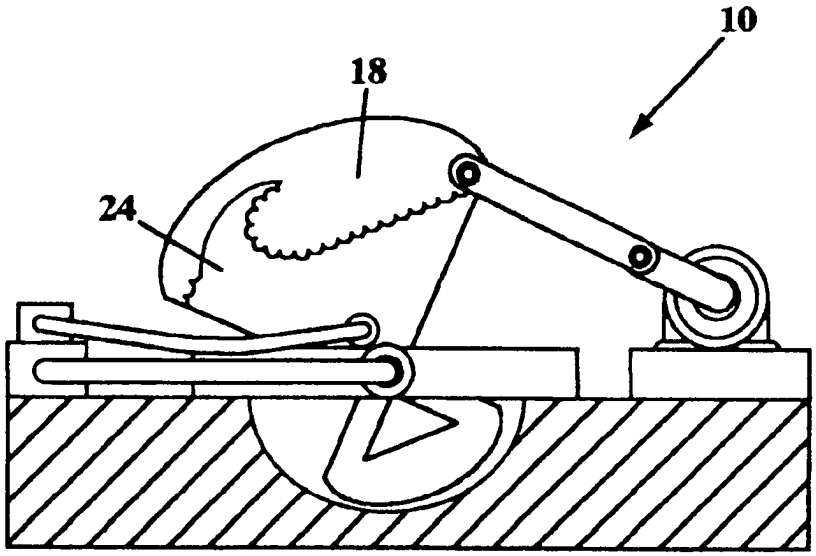

FIG. 6

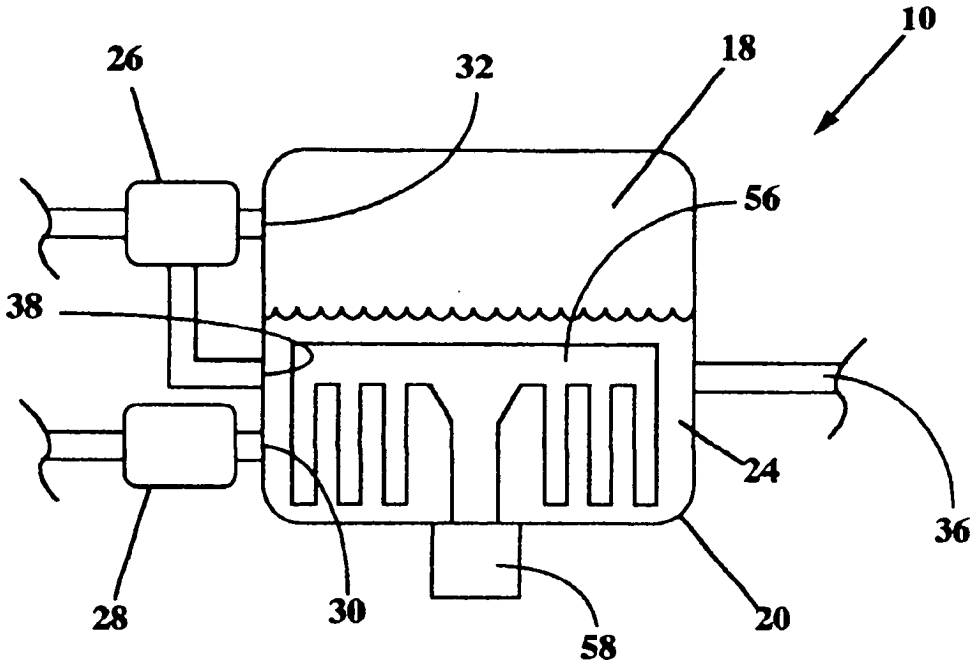
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FIG. 7

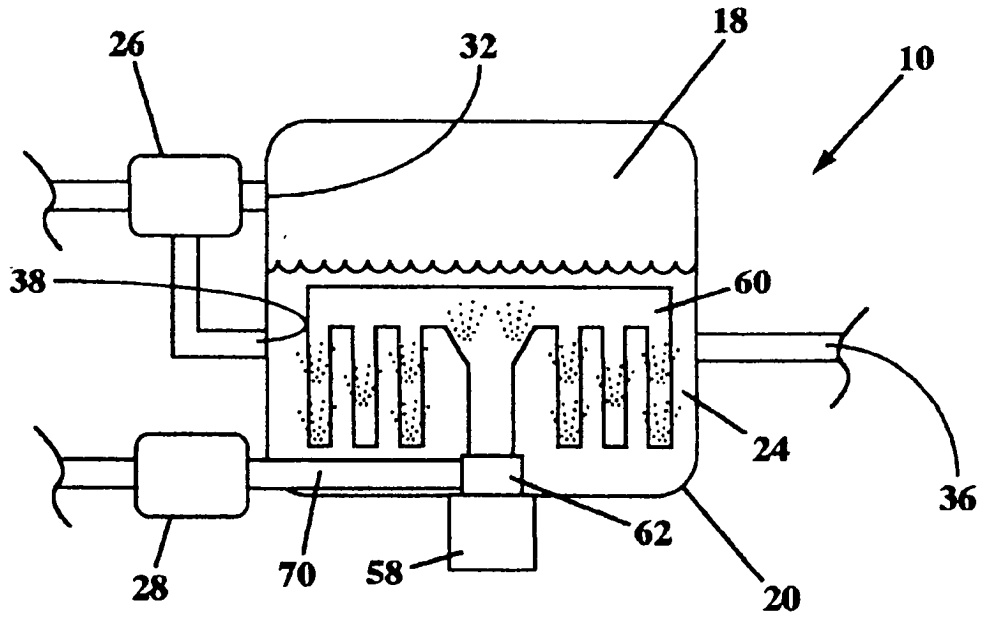
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FIG. 8

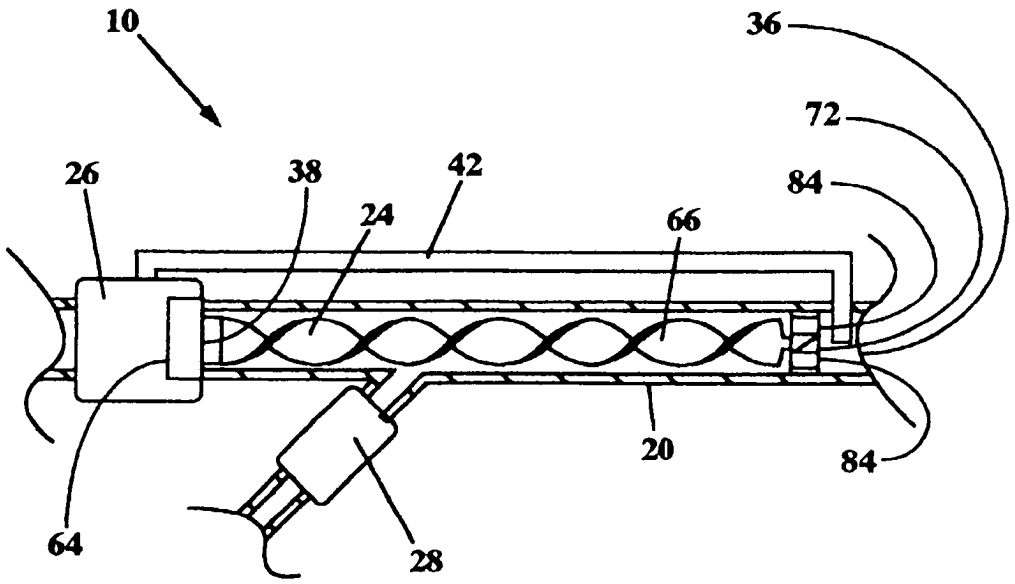

FIG. 9

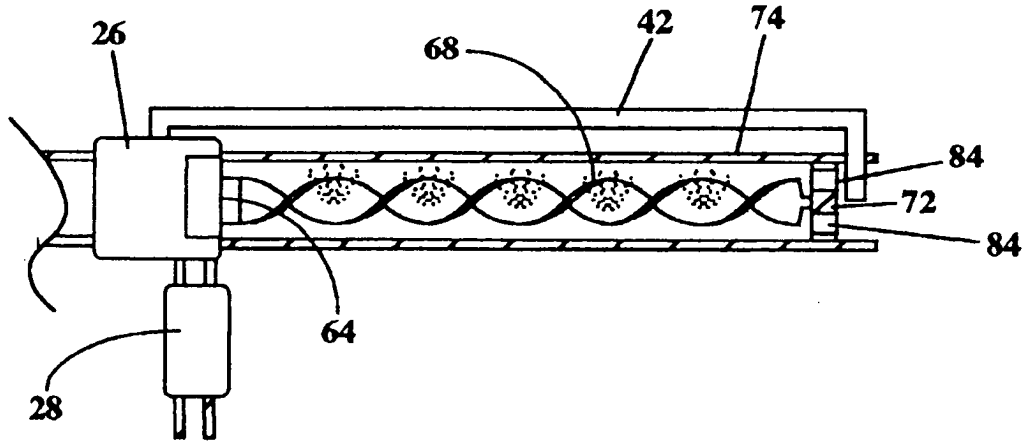

FIG. 10

ECONOMICAL APPARATUS FOR PRODUCING IMPROVED COMBUSTION AND SAFETY-ENHANCED FUEL

This is a non-provisional application which relies on provisional patent application, Ser. No. 60/089,376 filed on Jun. 15th of 1998.

OVERVIEW OF THE INVENTION

1. Field of the Invention

In co-pending patents (by two or more of the inventors of the present invention), practical methods are shown to provide and/or control safety-enhanced fuel and also improved combustion fuel in various types of fuel receptacles and fuel systems, including fuel systems of engine-powered vehicles and fuel-burning devices. These co-pending patents disclose the values of hydrocarbon fuel that is mixed with an inert gas (such as CO_2). The present invention discloses an economical method to produce safety-enhanced fuel comprising the incorporation of a hydrocarbon fuel and inert gas mixing apparatus which mixes highly absorbable inert gas(es) in hydrocarbon fuel.

2. Background of the Invention

Engine-powered vehicle safety is an important concern for all who travel. Numerous agencies, domestically and abroad, have been created and continue to operate with the sole purpose to monitor and improve systems, guidelines, and procedures, relating to the manufacture, maintenance and operation of travel and transportation vehicles. Most of these vehicles utilize some form of hydrocarbon fuel. The enormous power of hydrocarbon fuel is widely known, and when channelled properly it provides one of our most efficient sources of energy for travel, transportation and the like. However, the power of the fuel occasionally averts the safety designs of the systems that were created to control it, sometimes with tragic consequences. Some of these consequences, or their severity, may be significantly reduced or avoided completely, by the incorporation of a fuel within engine-powered vehicles which contains a high enough concentration of highly absorbable inert gas--within the fuel--as to be 'self-inerting fuel'. Indeed, in the wake of the tragic outcome of TWA Flight 800 out of New York, the FAA recently announced their desire to see aircraft incorporate some form of fuel inerting system, perhaps with the poignant realization that had the central fuselage tank of that 747 had a sufficient volume of inert gas therein, it would not have been able to support the ignition and combustion of the tank's volatile contents. Such public outcry for such a solution has typically implied a costly retrofitting of 25,000+ aircraft and/or manufacturing of expensive on-board aircraft 'hardware' solutions for new planes. The present invention requires little or no retrofitting of engine-powered vehicles and discloses an economical and efficient method to produce safety-enhanced fuel. For example, an inert gas such as CO_2, is highly absorbable in hydrocarbon fuel, and depending on various conditions can be absorbed into a hydrocarbon fuel up to a 3:1 ratio (and higher using positive pressures during mixing and/or storing). One volume of such hydrocarbon fuel can contain three times its own volume of absorbed CO_2, with a range of 1–2 times the CO_2 absorbable in many commercial fuels representing a more typical range (with higher mixing pressures additional absorption is possible). The molecular mixing of the fuel and the inert gas is highly efficient and synergistic in that the volume of the safety-enhanced fuel and its weight is minimally altered within the various ranges of gas-absorption. According to mixing

parameters that are controllable, such as the amount of pressure with which the inert gas is mixed into the fuel, the inert gas will desorb from the fuel into a fuel receptacle's ullage over time at predictable rates. It has been shown that a fuel receptacle ullage concentration of inert gas such as CO_2 in the range of 40–50% is, under most circumstances (including abnormally high temperatures), sufficient to prevent ignition or combustion of the remaining vapor and air mixture within the ullage. Since the volume of gas which can be absorbed in the fuel can readily exceed the volume of the fuel itself (without significantly altering the fuel volume or weight), it is possible to meet and exceed the 40–50% ignition-preventative range of inert gas needed in the fuel receptacle ullage as the fuel is used and as the inert gas contained in the remaining fuel continues to desorb from the fuel. Thus, little or no alteration is required of vehicles incorporating such safety-enhanced fuel, and an efficient and economical method to retrofit and increase the safety of vehicle's utilizing such fuels is provided. An additional benefit occurs with the presence of absorbed gas in fuel droplets allowing the gas to desorb as pressure falls or temperature rises, whereby the expanding gas bubbles (in the droplets) cause a separation of the droplets into micro-droplets which promotes better combustion of the fuel including substantial decreases in emissions and soot particulates.

In the case of an engine-powered vehicle such as a commercial jet for example, an aircraft will receive fuel containing a substantial volume of inert gas such as CO_2, as the plane awaits departure and then taxiis, factors such as time, fuel temperature increases and the mild agitation of taxiing and the subsequent take-off roll of the aircraft, assist in the desorption of CO_2 from the fuel. The inert gas will tend to stratify above the fuel and prevent the development of a potentially volatile layer of fuel vapor and air mixture. As the concentration of CO_2 within the ullage increases through desorption, the lighter volatile layer above it is forced out of the ullage through the fuel tank vents. Further purging is facilitated by the increase of altitude and the relative negative pressures associated therewith, which serve to draw out the uppermost layer of ullage-content. During the ascent phase and cruising phase of the aircraft, an additional gas-desorbing factor is introduced as the relative negative pressure of the surrounding air assists in drawing out CO_2 from the fuel into the ullage. With flights of longer durations (at cruising altitudes), the fuel and ullage are also cooled over time, which increases fuel ignition-preventative safety and increases the ability of the fuel to absorb and/or retain CO_2 therein until the descent phase of the flight where the warming of the fuel, and the agitation of the fuel during landing and subsequent taxiing, are additional factors which assist in the purging of remaining CO_2 from the fuel. As previously mentioned, mixing conditions such as temperature of the fuel and the pressure with which the inert gas is mixed into the fuel, affect absorpsion and desorption rates of the gas into and out of the fuel. Thus, it is possible to mix the inert gas with the hydrocarbon fuel under higher pressures for flights of shorter durations whereby the gas contained therein will desorb at a faster and optimal rate, and conversely to mix gas with fuel at lower pressures (including negative pressures whenever advantageous) for flights of longer durations. Alternatively, a conduit-receptacle having at least one controllable fuel inlet and at least one controllable inert gas inlet (including control of variable gas pressure ranges), with at least one controllable outlet, leading to a vehicle re-fueling station, can transmit any one, or combination, of: fuel and highly absorbable inert gas; or

safety-enhanced fuel; and improved combution fuel to the vehicle, or fuel-burning device. For example, with aircraft having flights of shorter durations (where the fuel tanks are intentionally only partially filled to minimize weight), it can be advantageous to first fill ullage(s) with inert gas before taking on safety-enhanced fuel. Higher pressure absorpsion rates are also employable for flights of shorter durations, thus the ullage of such tanks are quickly filled with the faster desorbing gas which can be optimally time-released for the flight's duration. Further, the control of inert gas mixing pressures can be used to facilitate the mixing of inert gas such as CO_2 into hydrocarbon fuels, e.g. diesel fuel, so that micro-droplets of fuel (facilitated by the absorbed CO_2 molecules) are obtained in the combustion phase of an engine to increase combustion efficiency and/or reduce carcinogenic materials (particularly with the burning of richer mixtures of fuel), thus increased engine performance and/or an improved operation as it relates to our environment, health and safety is achieved.

PRIOR ART

A search of patent literature has not disclosed methods to produce self-inerting or improved combustion fuel having a sufficient volume of inert gas containable therein to provide and/or sustain an ullage concentration of inert gas exceeding the 40–50% (nominal minimums) needed in order for the ullage contents to be considered ignition-preventative--or for the concentrations needed for improved combustion. Thus, the typical path, in the aircraft industry for example, has been the discussion or contemplation of manufacturing and retro-fitting all operational commercial aircraft with some kind of on-board 'hardware' inerting system. In that there are approximately 25,000+ such aircraft, such a path is considered daunting, time-consuming and extremely costly. For example, the inclusion of bulky and heavy auxiliary tanks for storing and routing inert gas such as Nitrogen has been considered, as well as inert gas generators, and various systems to capture and re-use gases from the aircraft engines. However, these systems have not proven to be either practical, effective, economical and/or reliable as of yet. Thus, the aircraft industry (as one of the largest sectors of engine-powered vehicles) is left in want of a practical, economical and readily employable solution. Furthermore, fuels with a concentration of absorbed CO2 of approximately 10% or greater, facilitate fuel/air mixing in the combustion zone of a fuel-burning device by providing a reduction in fuel droplet sizes. It is the purpose of the present invention to overcome such limitations and to provide such an alternative to the aircraft industry and to those industries and agencies concerned with the operation, combustion and safety of engine-powered vehicles, fuel-burning devices, and the fuel storage and/or fuel systems relating to such vehicles and devices. It is also the purpose of the present invention to provide an apparatus for facilitating the mixing, absorption and/or retention of inert gas (such as carbon dioxide 'CO2', nitrogen, or a plurality of inert gases) in hydrocarbon fuel, comprising a mixing receptacle having at least one coupling means for connection with a controllable inert gas supply; at least one coupling means for connection with a controllable hydrocarbon fuel supply; and at least one coupling means for connection with an inert gas-enriched or improved combustion fuel distribution means, and, the receptacle further comprising mixing apparatus suitable for controlling the exposure of hydrocarbon fuel molecules to an optimal volume of inert gas within said receptacle. One embodiment of the invention includes the adaptation of the apparatus to existing fuel-burning devices, i.e. for retrofitting thereto. The apparatus mixes and/or stores inert gas in the fuel to achieve one or more of the following benefits: fuel receptacle safety-enhancement; improved engine combustion; reduction in undesireable emissions; reduction in fuel droplet size; and/or, reduced fuel viscosity.

BRIEF DESCRIPTION OF DRAWINGS

All Figures are Diagrammatical

FIG. **1** is a view of a safety-enhanced or improved combustion fuel mixing apparatus according to the present invention showing a mixing receptacle wherein a controllable supply of inert gas and hydrocarbon fuel is mixed in controllable gas-fuel ratios ranging from 0.1:1to 3:1 gas concentrations within the fuel, and then controllably conveyed through at least one outlet of the receptacle.

FIG. **2** is a view of a safety-enhanced or improved combustion fuel mixing apparatus showing a receptacle having an inert gas infuser means contained substantially therein.

FIG. **3** is a view of a safety-enhanced or improved combustion fuel mixing apparatus showing a receptacle having a hydrocarbon fuel atomizer means and an inert gas infuser means contained substantially therein.

FIG. **4** is a view of a safety-enhanced or improved combustion fuel mixing apparatus showing a fuel conduit-receptacle having a gas diffuser contained therein and conduit means to convey safety-enhanced or improved combustion fuel.

FIG. **5** and FIG. **6** are views of a safety-enhanced or improved combustion fuel mixing apparatus shown with an external drive means actuating a movable mixing receptacle.

FIG. **7** and FIG. **8** are views of a safety-enhanced or improved combustion fuel mixing apparatus shown with a rotatable agitator means, with the agitator means of FIG. **8** further incorporating a gas diffuser means.

FIG. **9** and FIG. **10** are views of a safety-enhanced or improved combustion fuel mixing apparatus showing a fuel conduit-receptacle having a turbulator means contained therein and conduit means to transport safety-enhanced or improved combustion fuel, with the turbulator means of FIG. **10** further incorporating a gas diffuser means.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention provides an efficient and economical mixing apparatus **10** for exposing a controllable and/or optimal volume of inert gas such as CO_2 to a controllable and/or optimal volume of hydrocarbon fuel (e.g. Jet fuel, Diesel fuel, engine fuels, fuel oils and the like). As can be seen in the illustrations of FIGS. **1–4** and FIGS. **7–10**, the mixing apparatus **10** comprise at least one mixing receptacle **20** suitable for the mixing of fuel **24** and inert gas **18** therein, with mixing receptacle **20** having at least one controllable fuel inlet/coupling means **32** to receive hydrocarbon fuel from a hydrocarbon fuel supply as directed by fuel control means **26**, and at least one controllable gas inlet/coupling means **30** to receive inert gas such as CO_2 as directed by gas control means **28** from a controllable inert gas supply comprising one or more inert gas. Controllable inert gas inlet/coupling means **30** optionally includes the control means to determine fixed inert gas pressures, send pure inert gas through the mixing receptacle, and/or provide a variable range of inert gas pressures, including when appropriate, negative pressures. It is noted that when receptacle **20** and the coupling means that are attached thereto are so used they are comprised of a type of material suitable for withstanding such pressure differentials. For example in FIG. **2**, inert gas

control means **28** can in one variation, create a sufficient positive pressure of inert gas to impel it through the openings of the gaseous diffuser means **40** into the hydrocarbon fuel **24**. In an alternate variation, gas control means **28** can pump inert gas to a re-fueling location before the fuel control means initiates the pumping of fuel into the mixing receptacle, in which case an engine-powered vehicle's fuel tank ullage can receive a pure controllable dose of inert gas before re-fueling begins. In a third variation, gas control means **28** is optionally equipped with a vacuum pump, to create a negative pressure, for example via receptacle-content re-circulating conduit **38**, to create a sufficient negative pressure in the ullage **22** of mixing receptacle **20** to cause the inert gas to travel up through the hydrocarbon fuel **24** at a desired rate. It is noted that fuel control means **26** can optionally be supplied by any one or more of a variety of fuel sources including fuels suppliable in various temperatures such as chilled fuel, and/or fuel otherwise optimized for inert gas absorpsion such as hydrocarbon fuel with additional light hydrocarbon atoms. Similarly, inert gas such as CO2 can readily be stored in a chilled non-gaseous state e.g. liquid or solid and used as an inert gas supply—including a gas supply that when expanding during phase conversion provides a naturally occurring positive pressure source. In another embodiment of the present invention an inert gas supply can consist in, or be augmented by, the exhaust of a fuel-burning device which can be tapped by one or more suitable conduit and directed to the gas inlet of receptacle **20**. It is also noted that the apparatus of the present invention can be carried on and/or retrofitted on-board a vehicle or fuel-burning device whether tapping its exhaust and/or deriving inert gas from an independent supply such as one or more pressurized gas tank. Alternatively, mixing receptacle **20** can facilitate a passive mixing of inert gas-enriched fuel whereby the fuel and inert gas(es) within the receptacle are mixed by fluid convection which circulates fuel to the fluid surface creating contact with a controllable concentration of gas. Similarly, when receptacle **20** maintains an ullage which is sufficient in volume and having a suitable concentration of inert gas therein, a desired equilibrium fuel/gas ratio can be established and maintained within the inert gas-enriched fuel. Another passive mixing means is achieved within receptacle **20** when fuel entering the receptacle is splashed within a region of the receptacle that is also exposed to a controllable concentration of inert gas such as CO2, or when the fuel is directed over a splash-inducing contoured surface (not shown) as it is directed into, or descends into, the receptacle and is simultaneously exposed to an optimal concentration of gas.

Mixing receptacle **20** has one or more safety-enhanced or improved combustion fuel outlet/coupling means **36**, which is connectable with an inert gas-enriched fuel distribution means such as outlet control means **46**, to convey safety-enhanced fuel as needed. The control means **26**, **28** and **46**, are comprised of any one or more in a variety of known control device(s) such as automated, computer-controlled, or manually controlled, pump(s), valve(s), re-circulating device(s), manifold(s), and the like. Alternatively, the mixing receptacle(s) **20** can also comprise any one or more in a variety of known measuring and/or monitoring means **78**, such as monitoring, measuring, reporting device(s) and/or instruments used to measure or regularly sample pressure, temperature, chemistry composition, gas concentration levels, and the like, including the incorporation of monitoring means communication signal **80** with receptacle-content control means **82** (fuel control means **26**, inert gas control means **28**, and safety-enhanced fuel control means **46**, inclusively) in order to facilitate the automation of optimal mixing of the inert gas in the hydrocarbon fuel. Communication signal **80** can be transmitted through a suitable conduit connected between monitoring means **78** and any one or more of the control means, or alternatively can be transmitted by wireless transmission, in which case monitoring means **78** and any one or more of the control means are comprised of communicating transmitter(s) and receiver (s) respectively.

A first iteration of the present invention shown in FIGS. **1–4** and FIGS. **7–10**, includes a safety-enhanced or improved combustion fuel mixing means which is contained substantially within the interior of mixing receptacle(s) **20** and optionally includes one or more receptacle-content re-circulating conduit **38** for re-circulating or recycling inert gas, fuel, and/or safety-enhanced fuel within receptacle(s) **20**. The safety-enhanced or improved combustion fuel mixing means are comprised of any one or more in a variety of known gas/fuel mixers, including but not limited to: a fuel atomizer means **34** (FIG. **3**) such as one or more atomizing sprayer to spray liquid hydrocarbon fuel into a volume of inert gas; a gaseous diffuser means **40** (FIG.2) such as one or more gas diffuser means comprised of either a porous material, or a material having a multiplicity of apertures, either type of diffuser being suitable for releasing a multiplicity of small inert gas bubbles into a volume of hydrocarbon fuel; a fuel atomizer means **34** and/or gas diffuser means **40** (FIG. **3**); a gaseous diffuser means integrated into a safety-enhanced or improved combustion fuel transferring conduit (FIG. **4**); a rotatable agitator means (FIG. **7**); a combination rotatable agitator and gaseous diffuser means (FIG. **8**); a turbulator means (FIG.**9**); a combination turbulator and gaseous diffuser means (FIG. **10**); or, a carbonator means (not illustrated).

In FIG. **3** a safety-enhanced fuel mixing apparatus **10** is shown illustrating a mixing receptacle **20** having an internal hydrocarbon fuel atomizing means **34** and/or an inert gas diffuser means **40** (or inert gas infusing means). Fuel atomizing means **34** is controlled by fuel control means **26** which is connected to an external fuel source, and inert gas diffuser means **40** is controlled by gas control means **28** which is connected to an external inert gas source. An optional re-circulating conduit **38** is shown connected to each of the control means **26** and **28** respectively, such that the fuel and/or gas can readily be re-circulated within the mixing receptacle **20** as needed before being transferred out of safety-enhanced fuel outlet **36**. FIG. **4** illustrates a safety-enhanced fuel mixing apparatus **10** showing a fuel conduit-receptacle **74** having a gas diffuser means **40** contained therein and safety-enhanced fuel outlet **36** to further convey the gas-enriched fuel along an extended conduit (not shown) to a desired re-fueling location. In FIG. **4**, gas control means **28** pumps gas via inert gas inlet/coupling means **30** into at least one gas diffuser means **40**. Optionally, a gas diffuser means **40** can be extended internally along a length of fuel conduit-receptacle **74** for example through inlet **30**, such that an optimal length of the gas diffuser may be selected for a particular application. In either case, the fuel is driven by fuel control means **26** through fuel conduit-receptacle **74** adjacent to the gas diffuser means **40**, and can optionally be recycled via re-circulating conduit **38**.

A second iteration of the present invention illustrated in FIG. **5** and FIG. **6** shows a safety-enhanced or improved combustion fuel mixing apparatus which is substantially actuated by means external to the mixing receptacle(s) **20** wherein the mixing apparatus **10** comprises at least one movable or shakable mixing receptacle **20** suitable for

containing a volume of inert gas **18** which is received via inert gas inlet/coupling means **30** and a volume of hydrocarbon fuel **24** which is received via hydrocarbon fuel inlet **32**. Mixing receptacle **20** is actuated by externally connected propulsion means **50** such as a motor, engine, or any one or more in a variety of known drive means suitable to provide oscillatory cycling of receptacle **20**. FIG. **5** and FIG. **6** further show propulsion means **50** and mixing receptacle **20** with propulsion arms **48** and propulsion arm pivots **76** connected therebetween, such that the connected propulsion means are sufficient to actuate the movement of mixing receptacle **20** about a fixed receptacle pivot means **52**, such as a receptacle shaft operative within a friction-reducing means like a bushing or bearing (not shown). Optionally, a counter-balance weight **44** can be provided to facilitate the cycling of the mixing receptacle about its pivot point, and a counter-balance well **54** may also be incorporated when desired. Inert gas control means **26** and hydrocarbon fuel control means **28** are also shown resiliently connected to inlet **30** and inlet **32** respectively, such that mixing receptacle **20** is free to move with minimal movement of the connected control means. Optionally, in this mode of the present invention, fuel control means **26** can be dual-purposed to pump safety-enhanced or improved combustion fuel from mixing receptacle **20** after the fuel and gas have been suitably mixed. FIG. **6** illustrates a different phase of an oscillatory cycle of the mixing apparatus, wherein the agitation and mixing of hydrocarbon fuel **24** and inert gas **18** can readily be envisioned.

FIG. **7** and FIG. **8** illustrate mixing apparatus **10** having a rotatable agitator means **56**, with FIG. **8** further incorporating a rotatable agitator means **56** also having an integral gas diffuser means **60** which is connected to an inert gas supply, with the fuel, gas and safety-enhanced or improved combustion fuel, being controlled as described in one or more of the previous figures. In FIG. **7** and FIG. **8**, the agitator means **56** is affixed to and driven by, a controllable agitator drive means **58**, such as any one in a variety of known engines, motors, or combination of engine and rotatable transmission means, or combination of motor and rotatable transmission means, suitable for providing continuous rotation and/or oscillatory cycling of the agitator means **56** in either an automated, or a controlled manner. Agitator drive means **58** and agitator means **56** agitate the hydrocarbon fuel within mixing receptacle **20** such that the inert gas, whether also diffused or not, is readily mixed with the fuel. Agitator means **56** is illustrated having a shape to optimize mixing and it can be seen that numerous alternative shapes can also be provided.

FIG. **9** and FIG. **10** are views of a safety-enhanced or improved combustion fuel mixing apparatus **10**, showing a fuel conduit-receptacle **74** having a turbulator means **66** such as a rotatable elongated helix contained therein, and extendable conduit means to transport safety-enhanced fuel to a desired location, with FIG. **10** further illustrating a turbulator with an integrated gas diffuser means **68** rotatably connected to an inert gas source and gas control means **28**. Fuel, gas, safety-enhanced or improved combustion fuel, and re-circulation processes are provided and controlled in the manner described in one or more of the previous figures. Turbulator means **66** is rotatably mounted between a turbulator friction-reducing means **72** such as a bearing or bushing concentrically positioned within conduit-receptacle **74** (having one or more safety-enhanced or improved combustion fuel aperture **84**) and a turbulator drive means **64**, such as any one in a variety of known engines, motors, or combination of engine and transmission means, or combination of motor and transmission means, suitable for providing continuous rotation and/or oscillatory cycling of turbulator drive means **64** in a controlled manner. Safety-enhanced fuel aperture(s) **84** are sized to allow sufficient flow of safety-enhanced fuel therethrough.

Although the present invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made by way of example, and changes in detail or structure may be made without departing from the spirit of the invention in the previous descriptions or as defined in the appended claims.

What is claimed is:

1. A hydrocarbon fuel and carbon dioxide (CO2) mixing apparatus wherein a safety-enhanced and improved combustion CO2-enriched fuel is made, said mixing apparatus comprising at least one mixing receptacle suitable for retaining a volume of fuel and a volume of CO2, said mixing receptacle(s) having:

at least one coupling means for connection with a controllable CO2 supply;

at least one coupling means for connection with a controllable hydrocarbon fuel supply;

and at least one coupling means for connection with a CO2-enriched fuel distribution means, whereby

said CO2 supply and said hydrocarbon fuel supply are conveyable into said mixing receptacle(s) in controllable ratios and are conveyed into said mixing receptacle(s) in a manner that promotes fuel circulation and the mixing of said CO2 in said fuel, such that CO2-enriched fuel having a controllable gas-fuel ratio is the product of said mixing receptacle and the gas of said ratio(s) exceeds 0.1 volume of CO2 per volume of fuel and is less than 3 volumes per volume of fuel when conveyed from said receptacle(s) to said fuel distribution means.

2. The CO2-enriched fuel/product of the mixing apparatus of claim 1 wherein the control of concentrations of CO2 within said fuel/product produces micro-droplets in said fuel/product, yielding improved combustion and reduced soot particulate.

3. The mixing receptacle of claim 1 further comprising a receptacle-content monitoring means suitable for regularly sampling and reporting receptacle-content conditions to at least one receptacle-content control means.

4. The mixing receptacle of claim 3 further comprising at least one computer which is responsive to signal received from said receptacle-content monitoring means to control at least one controllable valve.

5. The mixing receptacle of claim 3 further comprising at least one computer which is responsive to signal received from said receptacle-content monitoring means to control at least one controllable pump.

6. The mixing receptacle and receptacle coupling means of claim 1 comprised of material suitable for mixing fuel and CO2 under pressure and for controlling the concentration of said CO2 within said fuel.

7. The mixing receptacle and receptacle coupling means of claim 1 comprised of material suitable for storing fuel and CO2 under pressure and for controlling the concentration of said CO2 within said fuel.

8. The mixing receptacle of the mixing apparatus of claim 1 further comprising coupling means to at least one receptacle-content re-circulation conduit.

9. The mixing receptacle of the mixing apparatus of claim 1 further comprising an ullage within said receptacle which is sufficient in volume when containing a controllable concentration of CO2, to establish a desired equilibrium gas/fuel ratio within the CO2-enriched fuel.

10. The mixing receptacle of claim 9 wherein fluid convection circulates fuel to the fluid surface creating contact with said controllable concentration of CO2.

11. The mixing apparatus of claim 1 comprising a fuel splash-inducing contoured surface which is aligned with the descent of the fuel into said mixing receptacle such that the fuel, as it splashes, is exposed to a controllable concentration of the CO2.

12. The CO2 supply of claim 1 wherein said CO2 is storable in a chilled non-gaseous state in a connectable receptacle.

13. The CO2 supply of claim 1 wherein said CO2 is provided by exhaust of a fuel-burning device.

14. The mixing apparatus of claim 1 further comprising a fuel atomizing means.

15. The mixing apparatus of claim 1 further comprising at least one CO2 infuser means.

16. The mixing apparatus of claim 1 further comprising at least one hydrocarbon fuel atomizer means and at least one CO2 infuser means.

17. The mixing apparatus of claim 1 further comprising at least one gas diffuser means.

18. The mixing apparatus of claim 1 further comprising an external drive means and a movable mixing receptacle wherein said drive means and said receptacle have an actuating member coupled therebetween such that a movement imparted to said member by said drive means causes said receptacle to move, which in turn, promotes the circulation of fuel within said receptacle.

19. The mixing apparatus of claim 1 further comprising a rotatable agitator means.

20. The mixing apparatus of claim 1 further comprising a combination rotatable agitator means and gas diffuser means.

21. The mixing apparatus of claim 1 further comprising a turbulator means.

22. The mixing apparatus of claim 1 further comprising a combination turbulator means and gas diffuser means.

23. The mixing apparatus of claim 1 which is configured to retrofit an existing fuel-burning device.

24. The CO2-enriched fuel/product of the mixing apparatus of claim 1 wherein the gas-to-fuel ratio of said CO2-enriched fuel is controllable and adjusted for the lengths of aircraft flights relative to the fuel volume in the fuel tanks of the aircraft departing on said flights.

* * * * *

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v. 8-95)

FILING RECEIPT

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
ASSISTANT SECRETARY AND COMMISSIONER
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APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTORNEY DOCKET NO.	DRWGS	TOT CL	IND CL
09/107,141	06/30/98	3753	$1,010.00	016499-546	0	30	3

E JOSEPH GESS
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Applicant(s)

KARL S. BEERS, UPPER DARBY, PA; CHARLES L. ANDERSON, WILMINGTON, DE.

TITLE
MULTIPLE ASM OBIGGS WITH DIFFERENT PERMEABILITY AND SELECTIVITY MEMBRANES

PRELIMINARY CLASS: 137

CS
016499-546
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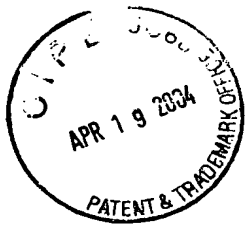

Patent
Attorney's Docket No. 016499-546

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

UTILITY PATENT
APPLICATION TRANSMITTAL LETTER

Box PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Enclosed for filing is the utility patent application of Karl S. BEERS and Charles L. ANDERSON for MULTIPLE ASM OBIGGS WITH DIFFERENT PERMEABILITY AND SELECTIVITY MEMBRANES.

Also enclosed are:

[ ] _____ sheet(s) of [ ] formal [ ] informal drawing(s);

[ ] a claim for foreign priority under 35 U.S.C. §§ 119 and/or 365 is [ ] hereby made to _ filed in __ on ___;
[ ] in the declaration;

[ ] a certified copy of the priority document;

[ ] a Constructive Petition for Extensions of Time;

[ ] _____ statement(s) claiming small entity status;

[ ] an Assignment document;

[ ] an Information Disclosure Statement; and

[ ] Other: _____.

The declaration of the inventor(s) [ ] also is enclosed [X] will follow.

[ ] Please amend the specification by inserting before the first line the sentence --This application claims priority under 35 U.S.C. §§119 and/or 365 to _ filed in _ on _; the entire content of which is hereby incorporated by reference.--

The filing fee has been calculated as follows [ ] and in accordance with the enclosed preliminary amendment:

CLAIMS					
	NO. OF CLAIMS		EXTRA CLAIMS	RATE	FEE
Basic Application Fee					$790.00
Total Claims	30	MINUS 20 =	10	x $22.00	$220.00
Independent Claims	3	MINUS 3 =	0	x $82.00	-0-
If multiple dependent claims are presented, add $270.00					-0-
Total Application Fee					$1010.00
If verified Statement claiming small entity status is enclosed, subtract 50% of Total Application Fee					-0-
Add Assignment Recording Fee of $40.00 if Assignment document is enclosed					-0-
TOTAL APPLICATION FEE DUE					**$1010.00**

[X] A check in the amount of $ 1010.00 is enclosed for the fee due.

[ ] Charge $ _____ to Deposit Account No. 02-4800 for the fee due.

Please address all correspondence concerning the present application to:

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Alexandria, Virginia 22313-1404.

The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§ 1.16, 1.17 and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800. This paper is submitted in triplicate.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

Date: June 30, 1998

By: _____
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(01/98)

UNITED STATES PATENT APPLICATION

FOR

MULTIPLE ASM OBIGGS WITH DIFFERENT PERMEABILITY AND SELECTIVITY MEMBRANES

BY

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MULTIPLE ASM OBIGGS WITH DIFFERENT PERMEABILITY AND SELECTIVITY MEMBRANES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to a method and system for inerting aircraft fuel tanks. The invention particularly relates to a method and system for providing nitrogen-enriched air (NEA) to aircraft fuel tanks using multiple air separation modules (ASMs). The ASMs employ membranes having different permeabilities and selectivities which are particularly selected to meet the varying NEA needs of the aircraft performance requirements.

2. Description of the Related Art

It is generally recognized that fuel vapors in an enclosed area such as a fuel tank may result in flame propagation or even an explosion if sufficient oxygen is present. The threat of an explosion, however, can be substantially reduced if the oxygen concentration in the fuel tank is lowered to 9% by volume or less.

Due to the risk of an explosion, some vehicles, particularly aircrafts, have been equipped with on-board inert gas generating systems (OBIGGS). The OBIGGS are intended to provide a supply of nitrogen or nitrogen-enriched gas to fill the vapor space or ullage in the fuel tank in order to lower its oxygen content and thereby reduce the possibility of an explosion.

Various OBIGGS have been proposed in the art. However, there remains a continuing need in the art for OBIGGS that have reduced size, weight, and operating cost, but yet can provide a sufficient amount and purity of NEA to inert, for example, aircraft fuel tanks during a variety of different operating conditions.

SUMMARY OF THE INVENTION

The present invention is intended to address this need in the art. It takes particular advantage of the fact that an aircraft has varying inert gas requirements during the course of its flight. For example, during level altitude or cruising, a relatively low rate of NEA flow is required to replace the fuel being used. During a descent maneuver such as landing, a higher rate of NEA flow is required to keep the internal pressure in the fuel tanks equal to the external pressure to minimize the in-rush of 21% by volume O_2 air and to maintain the ullage oxygen concentration at 9% by volume or lower. Likewise, during an ascent maneuver such as takeoff, a higher flow rate of NEA is required to inert the fuel tanks because of the evolution of dissolved O_2 from the fuel due to the drop in the atmospheric pressure.

Briefly, the present invention employs multiple gas separation modules which contain membranes having different permeabilities and selectivities to separate compressed air into NEA. The membrane modules are advantageously selected to provide the NEA required to inert the aircraft fuel tanks based on the

aircraft's particular performance requirements, while minimizing the system's overall size, weight, and operating cost.

More particularly, in its first aspect, the present invention relates to a method for inerting an aircraft fuel tank. The method comprises the steps of:

(a) contacting compressed air with one or more first membrane modules at conditions effective to produce a first nitrogen-enriched air stream;

(b) introducing the first nitrogen-enriched air stream into the fuel tank during periods of low demand for nitrogen-enriched air;

(c) contacting compressed air with one or more second membrane modules at conditions effective to produce a second nitrogen-enriched air stream; and

(d) introducing the second nitrogen-enriched air stream into the fuel tank during periods of high demand for nitrogen-enriched air. The first membrane modules have a lower O_2 permeance and a higher O_2/N_2 selectivity than the second membrane modules.

In its second aspect, the present invention relates to a system for inerting an aircraft fuel tank. The system comprises:

(a) one or more first membrane modules for separating compressed air into a first permeate stream comprising oxygen-enriched air and a first retentate stream comprising nitrogen-enriched air;

(b) a first conduit for conveying the first retentate stream into the fuel tank during periods of low demand for nitrogen-enriched air;

(c) one or more second membrane modules for separating compressed air into a second permeate stream comprising oxygen-enriched air and a second retentate stream comprising nitrogen-enriched air; and

(d) a second conduit for conveying the second retentate stream into the fuel tank during periods of high demand for nitrogen-enriched air. The first membrane modules have a lower O_2 permeance and a higher O_2/N_2 selectivity than the second membrane modules.

As used herein, the "periods of low demand for nitrogen-enriched air" refer to instances when the volumetric output of the one or more first membrane modules can produce enough NEA to maintain the oxygen concentration in the ullage of the aircraft fuel tank below the explosive limit, which is currently believed to be about 9% by volume or less. An example of such a period includes while the aircraft is cruising or is maintaining a level altitude.

On the other hand, the "periods of high demand for nitrogen-enriched air" refer to instances when the volumetric output of the one or more first membrane modules cannot produce enough NEA to maintain the oxygen concentration in the ullage of the aircraft fuel tank below the explosive limit. Such periods include during ascent, descent, and mid-air refueling.

DETAILED DESCRIPTION OF THE INVENTION

During level altitude or the cruising phase of an aircraft's flight, less NEA is required to maintain the oxygen concentration in the ullage of a fuel tank below

the explosive limit. Thus, it is possible to use more energy efficient, higher performance membrane modules to supply the required NEA.

Accordingly, during periods of low NEA demand, compressed air is contacted with one or more first membrane modules at conditions effective to produce a first NEA stream. The compressed air can be from any source on board the aircraft such as engine bleed air, bleed air from the aircraft's environmental control system, or air from an independent compressor. Regardless of the source of the compressed air, it typically contains about 21% by volume O_2, 78% by volume N_2, and traces of Ar and other gases. The air, however, may have a lower oxygen concentration at higher altitudes.

There is a relationship between the compressed air pressure, which translates to the driving force across the membrane, and the number of membrane modules required to perform the desired separation, and thus the overall size and weight of the system. For example, it has been discovered that increasing the compressed air pressure from 30 psig (308.0 kPa) to 50 psig (445.8 kPa) can reduce the module weight as well as its overall size by over 50%. Therefore, it is preferred that the compressed air has a pressure ranging from 10 psig (170.2 kPa) to 300 psig (2168.3 kPa), and more preferably, from 20 psig (239.1 kPa) to 100 psig (790.3 kPa). The driving force across the membrane can also be effected or enhanced by applying a vacuum on the permeate side of the membrane.

The first membrane modules contain a membrane material that preferentially permeates oxygen and retains nitrogen. In addition, they are

advantageously selected to have a lower O_2 permeance and a higher O_2/N_2 selectivity than the second membrane modules. Preferably, the first membrane modules are selected to have an O_2 permeance of at least 10 GPU (10^{-6} $cm^3/cm^2 \cdot sec \cdot cm\text{-}hg$) and an O_2/N_2 selectivity of at least 4.0 measured at operating conditions. More preferably, the first membrane modules have an O_2 permeance of at least 30 GPU (10^{-6} $cm^3/cm^2 \cdot sec \cdot cm\text{-}hg$) and an O_2/N_2 selectivity of at least 5.0.

Membrane modules having such properties are known in the art. They are generally referred to as high performance membranes. For example, but without limitation, the membrane material in the first modules can be made of cellulose derivatives, polyamides, polyimides, polyamide-imides, polysulfones, copolymers and blends thereof. The membrane material is preferably in the form of asymmetric or composite hollow fibers, but may be in roll form, and plate and frame cartridges. More preferably, the first membrane modules contain hollow fibers described in one of U.S. Patent Nos. 4,230,463; 4,983,191; 5,015,270; 5,085,676; and 5,096,468, and EP 0 207 721 A2; the contents of which are hereby incorporated by reference.

The temperature of the compressed air and/or the membrane has an affect on the permeability and selectivity of the membrane modules. For example, for a given compressed air flow rate and pressure, the permeability of the membrane can increase as the temperature increases. Thus, it is preferable to contact the compressed air with the first membrane modules at a temperature ranging from

0°C to 100°C, and preferably from 0°C to 80°C. Of course, the compressed air can be heated prior to the contacting step in order to maximize the productivity of the membrane modules.

The flow rate of the compressed air to the first membrane modules can vary, depending on the particular NEA requirements of the aircraft fuel tanks. Generally, however, the flow rate of the compressed air into the first membrane modules should be sufficient to provide enough NEA to the fuel tanks to maintain an oxygen concentration in the ullage space below the explosive range, i.e., 9% by volume O_2 or less, during periods of low demand such as cruising.

The first NEA stream preferably has a flow rate of 0.05 lbs/ min (0.023 kg/min) to 20 lbs/min (9.091 kg/min) and an oxygen content of 9% by volume or less. More preferably, the first NEA stream has a flow rate of 0.5 lbs/min (0.227 kg/min) to 2.0 lbs/min (0.909 kg/min) and an oxygen content of 5% by volume or less. The first NEA stream is advantageously introduced into the fuel tank of an aircraft during periods of low NEA demand to maintain the oxygen content in the ullage of the fuel tank below the explosive range.

During certain flight maneuvers such as ascent and descent, the first membrane modules may not be able to provide sufficient NEA flow to the aircraft's fuel tank to maintain the oxygen concentration in the ullage below the explosive limit. Thus, it would be advantageous to employ less efficient, but higher productivity membrane modules to supply the required NEA.

Like the first membrane modules, the second membrane modules contain a membrane material that preferentially permeates oxygen and retains nitrogen. The membrane material in the second modules, however, is preferably highly permeable so as to fulfill the high demand of NEA during flight periods such as ascent and descent.

The second membrane modules preferably have an O_2 permeance of at least 100 GPU (10^{-6} $cm^3/cm^2 \cdot sec \cdot cm\text{-}hg$) and an O_2/N_2 selectivity of at least 1.5 measured at operating conditions. More preferably, the second membrane modules have an O_2 permeance of at least 200 GPU (10^{-6} $cm^3/cm^2 \cdot sec \cdot cm\text{-}hg$) and an O_2/N_2 selectivity of at least 2.0. These membrane modules are usually referred to as having ultra high permeability.

Various such membrane materials are known in the art. For example, but without limitation, cellulose derivatives, polyamides, polyimides, polyamide-imides, polysulfones, copolymers and blends thereof have been found to be useful. The membrane materials are preferably in the form of asymmetric or composite hollow fibers, but may be in roll form, and plate and frame cartridges. More preferably, the second membrane modules contain hollow fibers described in one of U.S. Patent Nos. 4,717,394; 5,034,024; and 5,051,114, and EP 0 207 721 A2; the contents of which are hereby incorporated by reference.

The compressed air can be contacted with the second membrane modules at the same general conditions as it is contacted with the first membrane modules. However, because more NEA is needed to fill the ullage space during high NEA

demand periods, the second NEA stream generally, but not necessarily has a higher flow rate and a higher oxygen content than the first NEA stream.

The second NEA stream preferably has a flow rate of 5 lbs/min (2.273 kg/min) to 100 lbs/min (45.455 kg/min) and an oxygen content of 9% by volume or less. More preferably, the second NEA stream has a flow rate of 10 lbs/min (4.545 kg/min) to 50 lbs/min (22.727 kg/min). This second NEA stream is advantageously introduced into the fuel tank of an aircraft during periods of high NEA demand such as ascent and descent to maintain the oxygen content in the fuel tank below the explosive limit.

The second NEA stream can be introduced into the fuel tank in combination with or in lieu of the first NEA stream, depending on the particular NEA requirements of the aircraft at the time. To minimize energy consumption, one or more of the membrane modules in each set may be turned off when the NEA from those modules is not required to meet the demand of the aircraft.

Moreover, either one or both of the first and second NEA streams can be introduced directly into the liquid fuel in the fuel tank, such as through a bubbler, to scrub or remove dissolved O_2 from the fuel. Preferably, the first NEA stream is introduced into the liquid fuel. As those skilled in the art will readily appreciate, such an embodiment can reduce the risk of an explosion even further.

For both sets of membrane modules, if more than one is employed in each set, the modules in each set can be arranged in series and/or in parallel. If employed in series, the NEA retentate stream of one module can be used as a feed

to another module in that set. In addition, either the permeate stream or the retentate stream or both can be recycled to a previous module to maximize the separation efficiency of the modules.

In its second aspect, the present invention relates a system for carrying out the above-described process. The system contains two sets of membrane modules for separating compressed air into a permeate stream comprising oxygen-enriched air and a retentate stream comprising nitrogen-enriched air. Each set has a different permeability and selectivity. In particular, the first set of membrane modules is selected to have a lower O_2 permeance, but a higher O_2/N_2 selectivity than the second set of membrane modules.

Preferably, the first membrane modules have an O_2 permeance of at least 10 GPU (10^{-6} $cm^3/cm^2 \cdot sec \cdot cm\text{-}hg$) and an O_2/N_2 selectivity of at least 4.0, and the second membrane modules have an O_2 permeance of at least 100 GPU (10^{-6} $cm^3/cm^2 \cdot sec \cdot cm\text{-}hg$) and an O_2/N_2 selectivity of at least 1.5. More preferably, the first membrane modules have an O_2 permeance of at least 30 GPU (10^{-6} $cm^3/cm^2 \cdot sec \cdot cm\text{-}hg$) and an O_2/N_2 selectivity of at least 5.0, and the second membrane modules have an O_2 permeance of at least 200 GPU (10^{-6} $cm^3/cm^2 \cdot sec \cdot cm\text{-}hg$) and an O_2/N_2 selectivity of at least 2.0.

Both sets of membrane modules contain a compressed air inlet and an NEA stream outlet. Each NEA stream outlet is connected to a conduit which is provided to convey the NEA stream from the membrane modules to the ullage of the aircraft fuel tank. Each outlet can be connected to a separate conduit.

Alternatively, the outlets can be connected to a common conduit which carries the NEA into the fuel tank as needed. The system can also contain a third conduit for introducing the first NEA stream or the second NEA stream or both into the liquid fuel in the aircraft fuel tank in order to liberate at least a portion of O_2 dissolved in the fuel.

The first membrane modules and the second membrane modules can be arranged in a bundle-in-bundle configuration as described in U.S. Patent No. 5,013,331; the content of which is hereby incorporated by reference. For example, one first membrane module can be arranged as the outer bundle while one second membrane module can be the inner bundle. Such an arrangement can provide significant reductions in the overall size and weight of the system.

While the invention has been described with reference to preferred embodiments, it is to be understood that variations and modifications may be resorted to as will be apparent to those skilled in the art. Such variations and modifications are to be considered within the purview and scope of the invention as defined by the claims appended hereto.

WHAT IS CLAIMED IS:

1. A method for inerting an aircraft fuel tank, said method comprising the steps of:

(a) contacting compressed air with one or more first membrane modules at conditions effective to produce a first nitrogen-enriched air stream;

(b) introducing said first nitrogen-enriched air stream into said fuel tank during periods of low demand for nitrogen-enriched air;

(c) contacting compressed air with one or more second membrane modules at conditions effective to produce a second nitrogen-enriched air stream; and

(d) introducing said second nitrogen-enriched air stream into said fuel tank during periods of high demand for nitrogen-enriched air,

wherein said first membrane modules have a lower O_2 permeance and a higher O_2/N_2 selectivity than said second membrane modules.

2. The method according to claim 1, wherein said low demand periods include cruising.

3. The method according to claim 1, wherein said high demand periods include ascent or descent or both.

4. The method according to claim 1, further comprising introducing at least one of said first nitrogen-enriched air stream and said second nitrogen-enriched air stream into the fuel in said fuel tank at conditions effective to liberate at least a portion of dissolved O_2 in the fuel.

5. The method according to claim 4, wherein said first nitrogen-enriched air stream is introduced into the fuel in the fuel tank to liberate at least a portion of dissolved O_2 in the fuel.

6. The method according to claim 1, wherein said first nitrogen-enriched air stream has a lower flow rate than said second nitrogen-enriched air stream.

7. The method according to claim 1, wherein said first nitrogen-enriched air stream has a flow rate of 0.05 to 20 lbs/min at 9% by volume O_2 or less, and said second nitrogen-enriched air stream has a flow rate of 5 to 100 lbs/min at 9% by volume O_2 or less.

8. The method according to claim 7, wherein said first nitrogen-enriched air stream has a flow rate of 0.5 to 2.0 lbs/min at 5% by volume O_2 or less, and said second nitrogen-enriched air stream has a flow rate of 5 to 50 lbs/min at 9% by volume O_2 or less.

9. The method according to claim 1, wherein said first membrane modules have an O_2 permeance of at least 10 GPU and an O_2/N_2 selectivity of at least 4.0, and said second membrane modules have an O_2 permeance of at least 100 GPU and an O_2/N_2 selectivity of at least 1.5.

10. The method according to claim 9, wherein said first membrane modules have an O_2 permeance of at least 30 GPU and an O_2/N_2 selectivity of at least 5.0, and said second membrane modules have an O_2 permeance of at least 200 GPU and an O_2/N_2 selectivity of at least 2.

11. The method according to claim 1, wherein said compressed air comprises bleed air.

12. The method according to claim 1, wherein said compressed air has a pressure of 10 to 300 psig.

13. The method according to claim 1, which comprises introducing said first nitrogen-enriched air stream and said second nitrogen-enriched air stream into said fuel tank during periods of high demand for nitrogen-enriched air.

14. A method for inerting an aircraft fuel tank, said method comprising the steps of:

(a) contacting compressed air with one or more first membrane modules at conditions effective to produce a first nitrogen-enriched air stream;

(b) introducing said first nitrogen-enriched air stream into said fuel tank during cruising;

(c) contacting compressed air with one or more second membrane modules at conditions effective to produce a second nitrogen-enriched air stream; and

(d) introducing said second nitrogen-enriched air stream into said fuel tank during ascent or descent or both,

wherein said first membrane modules have a lower O_2 permeance and a higher O_2/N_2 selectivity than said second membrane modules.

15. The method according to claim 14, further comprising introducing at least one of said first nitrogen-enriched air stream and said second nitrogen-enriched air stream into the fuel in said fuel tank at conditions effective to liberate at least a portion of dissolved O_2 in the fuel.

16. The method according to claim 15, wherein said first nitrogen-enriched air stream is introduced into the fuel in the fuel tank to liberate at least a portion of dissolved O_2 in the fuel.

17. The method according to claim 14, wherein said first nitrogen-enriched air stream has a lower flow rate than said second nitrogen-enriched air stream.

18. The method according to claim 14, wherein said first nitrogen-enriched air stream has a flow rate of 0.05 to 20 lbs/min at 9% by volume O_2 or less, and said second nitrogen-enriched air stream has a flow rate of 5 to 100 lbs/min at 9% by volume O_2 or less.

19. The method according to claim 18, wherein said first nitrogen-enriched air stream has a flow rate of 0.5 to 2.0 lbs/min at 5% by volume O_2 or less, and said second nitrogen-enriched air stream has a flow rate of 5 to 50 lbs/min at 9% by volume O_2 or less.

20. The method according to claim 14, wherein said first membrane modules have an O_2 permeance of at least 10 GPU and an O_2/N_2 selectivity of at least 4.0, and said second membrane modules have an O_2 permeance of at least 100 GPU and an O_2/N_2 selectivity of greater than 1.5.

21. The method according to claim 20, wherein said first membrane modules have an O_2 permeance of at least 30 GPU and an O_2/N_2 selectivity of at

least 5.0, and said second membrane modules have an O_2 permeance of at least 200 GPU and an O_2/N_2 selectivity of at least 2.

22. The method according to claim 14, wherein said compressed air comprises bleed air.

23. The method according to claim 14, wherein said compressed air has a pressure of 10 to 300 psig.

24. The method according to claim 14, which comprises introducing said first nitrogen-enriched air stream and said second nitrogen-enriched air stream into said fuel tank during ascent or descent or both.

25. A system for inerting an aircraft fuel tank, said system comprising:

(a) one or more first membrane modules for separating compressed air into a first permeate stream comprising oxygen-enriched air and a first retentate stream comprising nitrogen-enriched air;

(b) a first conduit for conveying said first retentate stream into said fuel tank during periods of low demand for nitrogen-enriched air;

(c) one or more second membrane modules for separating compressed air into a second permeate stream comprising oxygen-enriched air and a second retentate stream comprising nitrogen-enriched air; and

(d) a second conduit for conveying said second retentate stream into said fuel tank during periods of high demand for nitrogen-enriched air,

wherein said first membrane modules have a lower O_2 permeance and a higher O_2/N_2 selectivity than said second membrane modules.

26. The system according to claim 25, further comprising a third conduit for introducing at least one of said first retentate stream and said second retentate stream into the fuel in said fuel tank to liberate at least a portion of dissolved O_2 in the fuel.

27. The system according to claim 25, wherein said first membrane modules have an O_2 permeance of at least 10 GPU and an O_2/N_2 selectivity of at least 4.0, and said second membrane modules have an O_2 permeance of at least 100 GPU and an O_2/N_2 selectivity of at least 1.5.

28. The system according to claim 27, wherein said first membrane modules have an O_2 permeance of at least 30 GPU and an O_2/N_2 selectivity of at least 5.0, and said second membrane modules have an O_2 permeance of at least 200 GPU and an O_2/N_2 selectivity of at least 2.

29. The system according to claim 25, wherein said first membrane modules and said second membrane modules are arranged in a bundle-in-bundle configuration.

30. The system according to claim 29, wherein said first conduit and said second conduit have common portions.

ABSTRACT OF THE DISCLOSURE

A method and system for providing nitrogen-enriched air (NEA) to aircraft fuel tanks using multiple air separation modules (ASMs). The ASMs employ membranes having different permeabilities and selectivities which are particularly selected to meet the varying NEA needs of the fuel tanks during flight.

COMBINED DECLARATION AND POWER OF ATTORNEY FOR UTILITY PATENT APPLICATION

Attorney's Docket No.
016499-546

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My residence, post office address and citizenship are as stated below next to my name;
I BELIEVE I AM THE ORIGINAL, FIRST AND SOLE INVENTOR (if only one name is listed below) OR AN ORIGINAL, FIRST AND JOINT INVENTOR (if more than one name is listed below) OF THE SUBJECT MATTER WHICH IS CLAIMED AND FOR WHICH A PATENT IS SOUGHT ON THE INVENTION ENTITLED:

MULTIPLE ASM OBIGGS WITH DIFFERENT PERMEABILITY
AND SELECTIVITY MEMBRANES

the specification of which

(check one) ☒ is attached hereto;
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I HAVE REVIEWED AND UNDERSTAND THE CONTENTS OF THE ABOVE-IDENTIFIED SPECIFICATION, INCLUDING THE CLAIMS, AS AMENDED BY ANY AMENDMENT REFERRED TO ABOVE;

I ACKNOWLEDGE THE DUTY TO DISCLOSE TO THE OFFICE ALL INFORMATION KNOWN TO ME TO BE MATERIAL TO PATENTABILITY AS DEFINED IN TITLE 37, CODE OF FEDERAL REGULATIONS, Sec. 1.56 (as amended effective March 16, 1992);

I do not know and do not believe the said invention was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to said application; that said invention was not in public use or on sale in the United States of America more than one year prior to said application; that said invention has not been patented or made the subject of an inventor's certificate issued before the date of said application in any country foreign to the United States of America on any application filed by me or my legal representatives or assigns more than twelve months prior to said application;

I hereby claim foreign priority benefits under Title 35, United States Code Sec. 119 and/or Sec. 365 of any foreign application(s) for patent or inventor's certificate as indicated below and have also identified below any foreign application for patent or inventor's certificate on this invention having a filing date before that of the application(s) on which priority is claimed:

COMBINED DECLARATION AND POWER OF ATTORNEY	Attorney's Docket No. 016499-546

COUNTRY/INTERNATIONAL	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			YES_ NO_
			YES_ NO_

I hereby appoint the following attorneys and agent(s) toprosecute said application and to transact all business in the Patent and Trademark Office connected therewith and to file, prosecute and to transact all business in connection with international applications directed to said invention:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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3644	

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Please find below and/or attached an Office communication concerning this application or proceeding.

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NOTICE UNDER 37 CFR 1.251 - Pending Application

☑ The file of the above-identified application cannot be located after a reasonable search. Therefore, the Office is initiating the reconstruction of the file of the above-identified application pursuant to the provisions of 37 CFR 1.251.

Applicant is given a period of **THREE (3) MONTHS** from the mailing date of this notice within which to provide a copy of applicant's record (if any) of all of the correspondence between the Office and applicant for the above-identified application (except for U.S. patent documents), a list of such correspondence, and a statement that the copy is a complete and accurate copy of applicant's record of all of the correspondence between the Office and the applicant for the above-identified application (except for U.S. patent documents), and whether applicant is aware of any correspondence between the Office and applicant for the above-identified application that is not among applicant's records.

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copy of the complete file (except the spec + claims).

Therefore, the Office is initiating the reconstruction of such paper(s) pursuant to the provisions of 37 CFR 1.251.

Applicant is given a period of **THREE (3) MONTHS** from the mailing date of this notice within which to provide a copy of the paper(s) listed above and a statement that the copy of such paper(s) is a complete and accurate copy of applicant's record of such paper(s).

Alternatively, applicant may reply to this notice by producing applicant's record (if any) of all of the correspondence between the Office and the applicant for the above-identified application for the Office to copy (except for U.S. patent documents), and provide a statement that the papers produced by applicant are applicant's complete record of all of the correspondence between the Office and the applicant for the above-identified application (except for U.S. patent documents), whether applicant is aware of any correspondence between the Office and the applicant for the above-identified application that is not among applicant's records. Such records must be brought to the Customer Service Center in the Office of Initial Patent Examination (Crystal Plaza 2, 2011 South Clark Place, Arlington, VA 22202).

If applicant does not possess any record of the correspondence between the Office and the applicant for the above-identified application (or any copy of the paper(s) listed above), applicant must reply to this notice by providing a statement that applicant does not possess any record of the correspondence between the Office and the applicant for the above-identified application.

Failure to reply to this notice in a timely manner will result in abandonment of the above-identified application. The three-month period for reply to this notice may be extended (up to a maximum of six months) under the provisions of 37 CFR 1.136(a). However, failure to reply within this three-month period will result in a reduction of any patent term adjustment. See 37 CFR 1.704(b).

☑ A printout from PALM of the contents of the file of the above-identified application is included with this notice.

Direct the reply to this notice to:

Box Reconstruction
United States Patent and Trademark Office
Washington, DC 20231

Direct questions concerning this notice to:

Joanne P. Hodge
(703) 306-4186

FORM PTO-2053-A (REV. 11/2000)

Patent
Attorney's Docket No. 016499-546

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	
Karl S. BEERS et al	Group Art Unit: 3644
Application No.: 09/107,141	Examiner: John W. Eldred
Filed: June 30, 1998	Confirmation No.: 7598
For: MULTIPLE ASM OBIGGS WITH DIFFERENT PERMEABILITY AND SELECTIVITY MEMBRANES	

INFORMATION DISCLOSURE STATEMENT TRANSMITTAL LETTER

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Enclosed is an Information Disclosure Statement and accompanying form PTO-1449 for the above-identified patent application.

[ ] No additional fee for submission of an IDS is required.

[X] The fee of $180.00 (126) as set forth in 37 C.F.R. § 1.17(p) is also enclosed.

[ ] A certification under 37 C.F.R. § 1.97(e) is also enclosed.

[ ] A certification under 37 C.F.R. § 1.97(e), and the fee of $180.00 (126) as set forth in 37 C.F.R. § 1.17(p) are also enclosed.

[ ] Charge $_____ to Deposit Account No. 02-4800 for the fee due.

[X] A check in the amount of $ 180.00 is enclosed for the fee due.

The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§ 1.16, 1.17 and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800. This paper is submitted in duplicate.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

By: Roger H. Lee
Roger H. Lee
Registration No. 46,317

P.O. Box 1404
Alexandria, VA 22313-1404
(703) 836-6620

Date: August 27, 2002

Patent
Attorney's Docket No. 016499-546

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	
	)	
Karl S. BEERS et al	)	Group Art Unit: 3644
	)	
Application No.: 09/107,141	)	Examiner: John W. Eldred
	)	
Filed: June 30, 1998	)	Confirmation No.: 7598
	)	
For: MULTIPLE ASM OBIGGS WITH DIFFERENT PERMEABILITY AND SELECTIVITY MEMBRANES	)	

INFORMATION DISCLOSURE STATEMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

In accordance with the duty of disclosure as set forth in 37 C.F.R. § 1.56, Applicants hereby submit the following information in conformance with 37 C.F.R. §§ 1.97 and 1.98. Pursuant to 37 C.F.R. § 1.98, a copy of each of the documents cited is enclosed.

A fee in the amount of $180.00 (126) is enclosed in conformance with 37 C.F.R. § 1.97(c).

To assist the Examiner, the documents are listed on the attached form PTO-1449. It is respectfully requested that an Examiner initialed copy of this form be returned to the undersigned.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

By: _____
Roger H. Lee
Registration No. 46,317

P.O. Box 1404
Alexandria, VA 22313-1404
(703) 836-6620

Date: August 27, 2002

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

ATTORNEY'S DKT NO.	APPLICATION NO.
016499-546	09/107,141
APPLICANT: Karl S. BEERS et al	
FILING DATE: June 30, 1998	GROUP: 3644

U.S. PATENT DOCUMENTS

Examiner Initials	U.S. Patent Document Number	Kind Code (if known)	Name of Patentee or Applicant of Cited Document	Date of Publication (MM-DD-YYYY)
	3,691,730		W. G. Hickey et al	09-19-1972
	3,948,626		K. R. Bragg	04-06-1976
	5,176,002	A	J. V. O'Brien et al	01-05-1993
	5,388,650	A	K. Michael	02-14-1995

FOREIGN PATENT DOCUMENTS

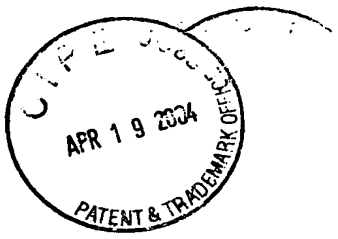
Examiner Initials	Foreign Patent Document Number	Kind Code (if known)	Country	Date of Publication (MM-DD-YYYY)	Translation Yes	Translation no
	WO 99 34106		WIPO	07-08-1999		
	WO 00 00389		WIPO	01-06-2000		

NON PATENT LITERATURE DOCUMENTS

Examiner Initials	Include name of author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.
	DOT/FAA/AR-00/19 Cavage, William, M., The Cost of Implementing Ground-Based Fuel Tank Inerting in the Commercial Fleet, National Technical Information Service, Springfield, VA 22161, Final Report May 2000
	Air Liquide - MEDAL's Air Separation Membrane - The Technology at the Heart of OBIGGS, Inerting Task Group Presentation, Fuel Tank Harmonization Working Group, 18 March 1998
	Air Liquide - GBI Cost Analysis - NEA System Architecture, GBI Cost Study 29 February 2000
	Aviation Rulemaking Advisory Committee Fuel Tank Harmonization Working Group Final Report July, 1998 (Parts 1 of 3, 2 of 3, and 3 of 3)
	Timpe, Ronald C., et al, Flight Safety, Endurance, and Evaporative Emissions Improvement Via Jet Fuel-Cooling - Polarjet® Fuel Treatment Demonstration, University of North Dakota, October 1999
	Air Liquide Brochures for APSA® Advanced Product Supply Approach; FLOXAL® Nitrogen Membrane System; SOLVAL® VOC Removal and Recovery System; and VESTAL-02 Control Unit.

Examiner Signature		Date Considered	

EXAMINER: Initial if reference considered. whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not



P.
Attorney's Docket No. 016499-54

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	
	)	
Karl S. BEERS et al	)	Group Art Unit: 3644
	)	
Application No.: 09/107,141	)	Examiner: John W. Eldred
	)	
Filed: June 30, 1998	)	Confirmation No.: 7598
	)	
For: MULTIPLE ASM OBIGGS WITH DIFFERENT PERMEABILITY AND SELECTIVITY MEMBRANES	)	

AMENDMENT/REPLY TRANSMITTAL LETTER

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Enclosed is a reply for the above-identified patent application.

[X] A Petition for Extension of Time is also enclosed.

[ ] A Terminal Disclaimer and a check for [ ] $55.00 (248) [ ] $110.00 (148) to cover the requisite Government fee are also enclosed.

[ ] Also enclosed is _____.

[ ] Small entity status is hereby claimed.

[ ] Applicant(s) request continued examination under 37 C.F.R. § 1.114 and enclose the [ ] $370.00 (279) [ ] $740.00 (179) fee due under 37 C.F.R. § 1.17(e).

[ ] Applicant(s) previously submitted ___, on ___, for which continued examination is requested.

[ ] Applicant(s) request suspension of action by the Office until at least _, which does not exceed three months from the filing of this RCE, in accordance with 37 C.F.R. § 1.103(c). The required fee under 37 C.F.R. § 1.17(i) is enclosed.

[ ] A Request for Entry and Consideration of Submission under 37 C.F.R. § 1.129(a) (146/246) is also enclosed.

[X] No additional claim fee is required.

[ ] An additional claim fee is required, and is calculated as shown below:

AMENDED CLAIMS					
	NO. OF CLAIMS	HIGHEST NO. OF CLAIMS PREVIOUSLY PAID FOR	EXTRA CLAIMS	RATE	ADDT'L FEE
Total Claims		MINUS =		× $18.00 (103) =	
Independent Claims		MINUS =		× $84.00 (102) =	
If Amendment adds multiple dependent claims, add $280.00 (104)					
Total Amendment Fee					
If small entity status is claimed, subtract 50% of Total Amendment Fee					
TOTAL ADDITIONAL FEE DUE FOR THIS AMENDMENT					

[ ] A claim fee in the amount of $_____ is enclosed.

[ ] Charge $_____ to Deposit Account No. 02-4800.

The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§ 1.16, 1.17, 1.20(d) and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800. This paper is submitted in duplicate.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

By: _____
E. Joseph Gess
Registration No. 28,510

P.O. Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620

Date: July 1, 2002

Patent
Attorney's Docket No. 016499-546

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	
	)	
Karl S. BEERS et al	)	Group Art Unit: 3644
	)	
Application No.: 09/107,141	)	Examiner: John W. Eldred
	)	
Filed: June 30, 1998	)	Confirmation No.: 7598
	)	
For: MULTIPLE ASM OBIGGS WITH DIFFERENT PERMEABILITY AND SELECTIVITY MEMBRANES	)	

PETITION FOR EXTENSION OF TIME

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

The following extension of time is requested to respond to the outstanding Official Action dated January 30, 2002 :

two months to July 1, 2002 ; the extension fee is:

[ ] $200.00 (216) [X] $400.00 (116).

[ ] The shortened statutory period has been reset by an Advisory Action dated _____.

[X] An extension fee in the amount of $ 400.00 is enclosed.

The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§ 1.16, 1.17 and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800. This paper is submitted in duplicate.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

By: _____
E. Joseph Gess
Registration No. 28,510

P.O. Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620

Date: July 1, 2002

Patent
Attorney's Docket No. 016499-546

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	
	)	
Karl S. BEERS et al	)	Group Art Unit: 3644
	)	
Application No.: 09/107,141	)	Examiner: John W. Eldred
	)	
Filed: June 30, 1998	)	
	)	
For: MULTIPLE ASM OBIGGS WITH DIFFERENT PERMEABILITY AND SELECTIVITY MEMBRANES	)	

REPLY

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

In response to the Official Action dated January 30, 2002, Applicants submit the following remarks.

REMARKS

Re-examination and reconsideration of the application identified in caption pursuant to and consistent with 37 C.F.R. §1.111 and in light of the remarks which follow, are respectfully requested.

Claims 1-3, 5-14, 16-25 and 27-31 are pending in the present application. Each of these claims is under consideration.

In the Official Action, claims 1-3, 11, 13, 14, 16, 17, 22, 24, 25, 29 and 30 stand rejected under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 5,013,331 (*Edwards et al*) in view of U.S. Patent No. 6,293,525 (*Ginsburgh et al*). This rejection should be withdrawn for at least the following reasons.

According to one aspect of the present invention as defined by claim 1, a method for inerting an aircraft fuel tank is provided. The method comprising the steps of: (a) contacting compressed air with one or more first membrane modules at conditions effective to produce a first nitrogen-enriched air stream; (b) introducing said first nitrogen-enriched air stream into said fuel tank during periods of low demand for nitrogen-enriched air; (c) contacting compressed air with one or more second membrane modules at conditions effective to produce a second nitrogen-enriched air stream; and (d) introducing said second nitrogen-enriched air stream into said fuel tank during periods of high demand for nitrogen-enriched air. Said first membrane modules have a lower O_2 permeance and a higher O_2/N_2 selectivity than said second membrane modules. At least one of said first nitrogen-enriched air stream and said second nitrogen-enriched air stream is introduced directly into the fuel in said fuel tank at conditions effective to liberate at least a portion of dissolved O_2 in the fuel. Additional aspects of the present invention are defined by independent claims 14, 25 and 31.

Edwards et al does not disclose or suggest each feature of the presently claimed invention. For example, the inventive methods according to claims 1 and 14 include introducing a nitrogen-enriched air stream directly into a fuel in a fuel tank at conditions effective to liberate at least a portion of dissolved O_2 in the fuel. Similarly, the inventive systems according to claims 25 and 31 include a conduit for introducing a retentate stream directly into a fuel in a fuel tank to liberate at least a portion of dissolved O_2 in the fuel. *Edwards et al* has no disclosure or suggestion of such features. In fact, *Edwards et al* has no disclosure or suggestion of introducing a nitrogen-

enriched air stream directly into a fuel in a fuel tank[1], let alone at conditions effective to liberate at least a portion of dissolved O_2 in the fuel.

Like *Edwards et al*, *Ginsburgh et al* fails to disclose or suggest introducing a nitrogen-enriched air stream directly into a fuel in a fuel tank at conditions effective to liberate at least a portion of dissolved O_2 in the fuel. In fact, *Ginsburgh et al* has no recognition or suggestion of the presence of dissolved oxygen in the fuel, let alone introducing a nitrogen-enriched air stream directly into the fuel at conditions effective to liberate a portion of such dissolved oxygen. Moreover, the Official Action fails to provide any reason why one of ordinary skill in the art would have been motivated to modify *Edwards et al* and/or *Ginsburgh et al* to introduce a nitrogen-enriched air stream directly into a fuel in a fuel tank at conditions effective to liberate at least a portion of dissolved O_2 in the fuel.

Furthermore, the inventive methods and systems include a first membrane module which produces nitrogen-enriched air employed during periods of low demand thereof, which has a lower O_2 permeance and a higher O_2/N_2 selectivity than a second membrane module which produces nitrogen-enriched air employed during periods of high demand thereof. Advantageously, the present invention enables the use of a membrane module having a higher O_2 permeance and a lower O_2/N_2 selectivity (i.e., the second membrane module) to provide an increased nitrogen-enriched air flow rate during periods of higher nitrogen-enriched air demand.

Edwards et al does not disclose or suggest such a feature. In this regard, *Edwards et al* discloses that "portion 88 could provide one purity product and portion 90 could provide another

---

[1]This deficiency of *Edwards et al* is acknowledged at page 2 of the Official Action.

purity product from the same feed" (*Edwards et al* at col. 7, lines 33-36). However, *Edwards et al* has no recognition or suggestion of employing nitrogen-enriched air produced by a first membrane module having a lower O_2 permeance and a higher O_2/N_2 selectivity in comparison with a second membrane module, during periods of low demand of nitrogen-enriched air.

Rather, *Edwards et al* discloses providing an increased nitrogen-enriched air flow rate by using a portion of a permeator with a "higher capacity", or by utilizing flows from two portions of the permeator (*Edwards et al* at col. 11, lines 50-55). Absent an improper resort to Applicants' own disclosure, one of ordinary skill in the art would not have been motivated to select a first membrane module which provides nitrogen-enriched air for use during periods of low demand thereof, which has a lower O_2 permeance and a higher O_2/N_2 selectivity than a second membrane module which provides nitrogen-enriched air for use during periods of high demand thereof. Further, *Ginsburgh et al* does not even relate to the use of membrane modules for producing nitrogen-enriched air, let alone the O_2 permeance and O_2/N_2 selectivity characteristics of such membrane modules, and as such fails to cure the above-described deficiency of *Edwards et al*.

Accordingly, for at least the reasons set forth above, withdrawal of the §103(a) rejection over *Edwards et al* and *Ginsburgh et al* is respectfully requested.

Claims 4, 5-10, 12, 15, 16, 18, 19-21, 23, 26-28 and 31 stand rejected under 35 U.S.C. §103(a) as being obvious over *Edwards et al* in view of *Ginsburgh et al*, and further in view of "Aviation Week and Space Technology", Vol. 147, No. 2, pp. 60-61 (*Dornheim*). Withdrawal of this rejection is respectfully requested for at least the following reasons.

The deficiencies of *Edwards et al* and *Ginsburgh et al* are discussed above.

The Examiner relies on *Dornheim* for disclosing that "oxygen enrichment occurs from the dissolved air in the fuel" (Official Action at page 3). However, like *Edwards et al* and *Ginsburgh et al*, *Dornheim* fails to disclose or suggest introducing a nitrogen-enriched air stream directly into a fuel in a fuel tank at conditions effective to liberate at least a portion of dissolved O_2 in the fuel. In stark contrast with the present invention, *Dornheim* discloses the use of a centrifugal aspirator/scrubber to reduce the amount of oxygen dissolved in incoming fuel during refueling. There is simply no disclosure or suggestion that introducing a nitrogen-enriched air stream directly into a fuel in a fuel tank is effective to liberate at least a portion of dissolved O_2 in the fuel.

In this regard, the Official Action at page 3 states the following:

> To substitute particular parameters and conditions in the fuel inherting [sic] system of Edwards et al in place of unspecified conditions are considered to have been a matter of design and engineering choice in order to achieve the desired performance of the system in a particular situation.

Applicant's respectfully disagree with the Examiner's position. It is noted that the Patent Office must show that the prior art teaches or suggests all the claim limitations in order to establish a *prima facie* case of obviousness.[2] However, in the present case, not one of the applied documents has any recognition or suggestion of introducing a nitrogen-enriched air stream directly into a fuel in a fuel tank at conditions effective to liberate at least a portion of dissolved O_2 in the fuel.

Furthermore, like *Edwards et al* and *Ginsburgh et al*, *Dornheim* fails to disclose or suggest a first membrane module which produces nitrogen-enriched air employed during periods of low demand thereof, which has a lower O_2 permeance and a higher O_2/N_2 selectivity than a

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[2]See, e.g., M.P.E.P. §2143.

second membrane module which produces nitrogen-enriched air employed during periods of high demand thereof.

Accordingly, for at least the reasons set forth above, withdrawal of the §103(a) rejection over *Edwards et al*, *Ginsburgh et al* and *Dornheim* is respectfully requested.

From the foregoing, further and favorable action in the form of a Notice of Allowance is believed to be next in order, and such action is earnestly solicited. If the Examiner has any questions concerning this paper, or the application in general, the Examiner is invited to telephone the undersigned.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

By: _____
E. Joseph Gess
Registration No. 28,510

P.O. Box 1404
Alexandria, VA 22313-1404
(703) 836-6620

Date: July 1, 2002

Patent
Attorney's Docket No. 016499-546

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	Attention: **DRAFTING BRANCH**
Karl S. BEERS et al	)	Confirmation No.: 7598
Application No.: 09/107,141	)	Group Art Unit: 3644
Filed: June 30, 1998	)	Examiner: John W. Eldred
For: MULTIPLE ASM OBIGGS WITH DIFFERENT PERMEABILITY AND SELECTIVITY MEMBRANES	)	

SUBMISSION OF FORMAL DRAWINGS

Assistant Commissioner for Patents
Washington, D.C. 20231

ATTN: OFFICIAL DRAFTSMAN

Sir:

Enclosed please find one sheet of formal drawings for review by the Patent and Trademark Office in connection with the above-identified application. Should the enclosed drawings require changes, it is respectfully requested that the Patent and Trademark Office notify the undersigned of same.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

By: _____
Roger H. Lee
Registration No. 46,317

P.O. Box 1404
Alexandria, VA 22313-1404
(703) 836-6620

Date: August 5, 2002

(05/02)

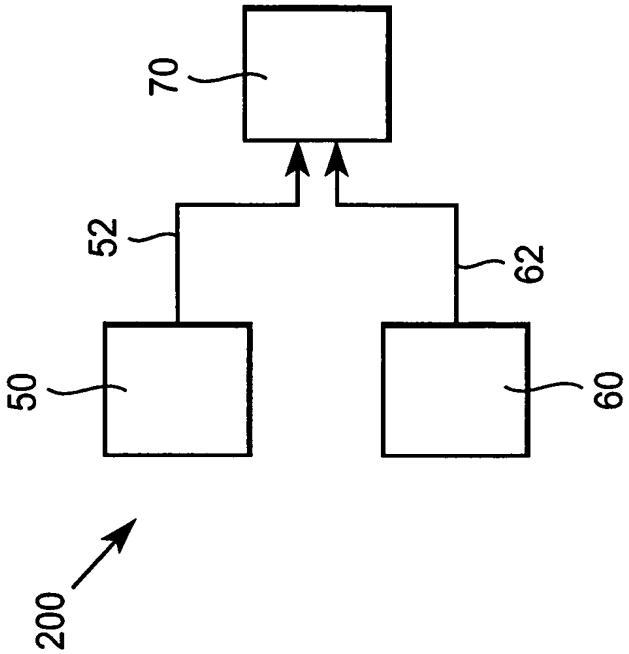

FIG. 2

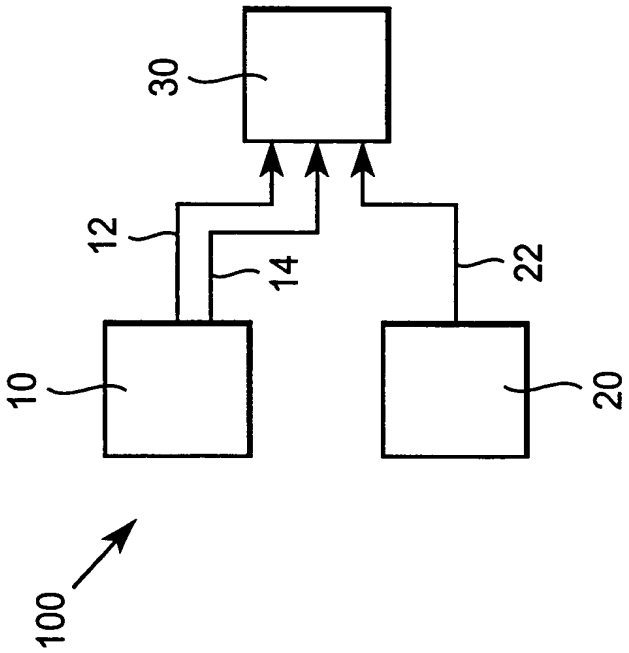

FIG. 1

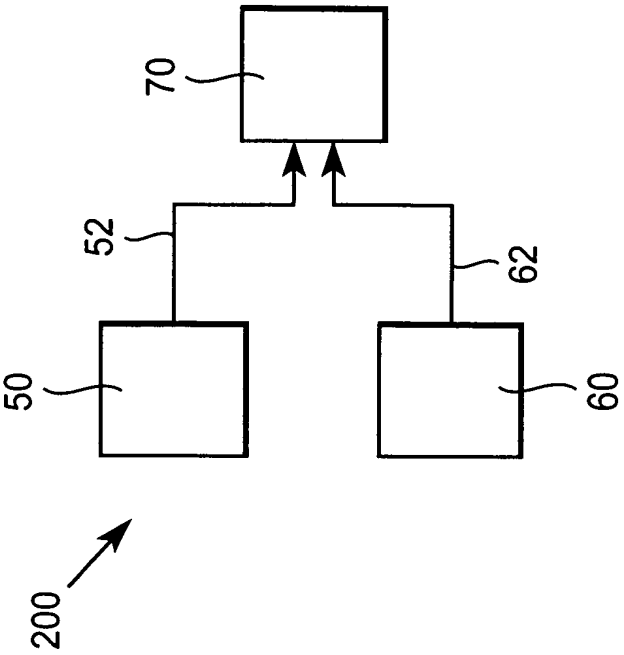

FIG. 2

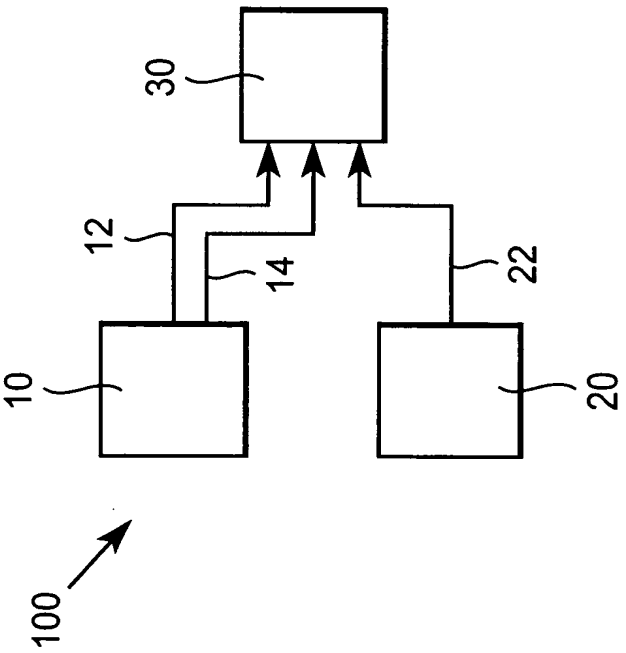

FIG. 1

S.4572

INFORMATION DISCLOSURE CITATION

PTO-1449

ATTORNEY'S DKT NO.	APPLICATION NO.
016499-546	CPA of 09/107,141
APPLICANT: Karl S. BEERS et al.	
FILING DATE: January 28, 2000	GROUP: 3644

U.S. PATENT DOCUMENTS

EXAMINER'S INITIALS	PATENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE
~~—~~	~~4,378,920~~	~~04/05/83~~	~~Runnels et al.~~			
JNE	4,397,661	08/09/83	King et al.	55	158	

FOREIGN PATENT DOCUMENTS

EXAMINER'S INITIALS	PATENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	Translation Yes	Translation No
JNE	2 264 566	10/17/75	FRANCE	—	—		

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

JNE	"Airline Industry Takes Fresh Look At Inerting", Aviation Week and Space Technology, U.S. McGraw-Hill, Inc., Vol. 147, No. 2, pp. 60-61, Dornheim M.A.
JNE	"The Evolution of On-Board Inert Gas Generation Systems (OBIGGS)", 27th Annual Symposium on Safe Association, December 5-8, 1989, pp. 19-24, XP002122565

EXAMINER	DATE CONSIDERED
Woodrow Eldred	3-10-00

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE CITATION

PTO-1449

ATTORNEY'S DKT NO.	APPLICATION NO.
016499-546	09/107,141
APPLICANT: Karl S. BEERS et al.	
FILING DATE: June 30, 1998	GROUP: 3753

U.S. PATENT DOCUMENTS

EXAMINER'S INITIALS	PATENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE
KWE	4,230,463	10/28/80	Henis et al.	55	16	
KWE	4,556,180	12/03/85	Manatt	244	135	
KWE	4,681,602	07/21/87	Glenn et al.	55	21	
KWE	4,717,394	01/05/88	Hayes	55	16	
KWE	4,983,191	01/08/91	Ekiner er al.	55	158	
KWE	5,013,331	05/07/91	Edwards et al.	55	16	
KWE	5,015,270	05/14/91	Ekiner et al.	55	16	
KWE	5,034,024	07/23/91	Hayes	55	16	
KWE	5,051,114	09/24/91	Nemser et al.	55	16	
KWE	5,085,676	02/04/92	Ekiner et al.	55	158	
KWE	5,096,468	03/17/92	Minhas	55	16	

FOREIGN PATENT DOCUMENTS

EXAMINER'S INITIALS	PATENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	Translation Yes	Translation No
KWE	207 721	01/07/87	EP	—	—		

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

EXAMINER	DATE CONSIDERED
Woodrow Eldred	9-27-99

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Notice of References Cited

Application No.	Applicant(s)		
09/107,141	Beers		
Examiner	**Group Art Unit**	**Page**	
Woodrow Eldred	3644	1 of 1	

U.S. PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS
✓	A	3,691,730	9-1972	Hickey et al	55	166
✓	B	4,378,920	4-1983	Runnels et al	244	135 R
✓	C	4,627,243	12-1986	Schaub	62	52
✓	D	4,958,659	9-1990	Dowdall	137	624.12
✓	E	4,972,866	11-1990	Anthony et al	137	110
	F					
	G					
	H					
	I					
	J					
	K					
	L				—	
	M					

FOREIGN PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUBCLASS
	N						
	O						
	P						
	Q						
	R						
	S						
	T						

NON-PATENT DOCUMENTS

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/107,141	06/30/1998	~~KARL~~ S. BEERS	016499-546	7598

21839 7590 01/30/2002

BURNS DOANE SWECKER & MATHIS L L P
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

EXAMINER
ELDRED, JOHN W

ART UNIT	PAPER NUMBER
3644	

DATE MAILED: 01/30/2002

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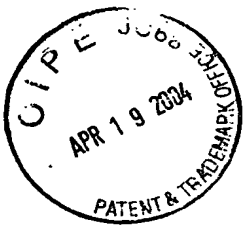

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- ☐ Application for Patent including _____ pgs. Spec., _____ Claims
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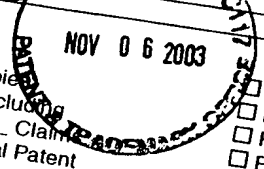

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Approved for use through 11/30/2005. OMB 0651-0035
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CHANGE OF CORRESPONDENCE ADDRESS
Application

Address to:
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450.

Application Number	09/107,141
Filing Date	June 30, 1998
First Named Inventor	Karl S. Beers
Art Unit	3753
Examiner Name	John W. Eldred
Attorney Docket Number	S4572

Please change the Correspondence Address for the above-identified patent application to:

☐ Customer Number :

OR

☒ Firm or Individual Name	Linda K. Russell				
Address	Air Liquide				
Address	2700 Post Oak Blvd., Suite 1800				
City	Houston	State	TX	Zip	77056
Country	USA				
Telephone	(713) 624-8956	Fax	(713) 624-8950		

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I am the:

☐ Applicant/Inventor

☒ Assignee of record of the entire interest.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96).

☐ Attorney or Agent of record. Registration Number _____.

☐ Registered practitioner named in the application transmittal letter in an application without an executed oath or declaration. See 37 CFR 1.33(a)(1). Registration Number_____.

Typed or Printed Name	Linda K. Russell, Reg. No. 34,918
Signature	Linda K. Russell
Date	November 4, 2003
Telephone	(713) 624-8956

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☐ *Total of _____forms are submitted.

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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Karl S. Beers, et al

Application No./Patent No.: 09/107,141 Filed/Issue Date: June 30, 1998

Entitled: Multiple ASM OBIGGS with different permeability and selective membranes

L'Air Liquide, Société Anonyme à Directoire et Conseil de Surveillance pour l'Etude et l'Exploitation des Procédés Georges Claude a corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. [X] the assignee of the entire right, title, and interest; or

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The extent (by percentage) of its ownership interest is _____ %
in the patent application/patent identified above by virtue of either:

A. [x] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 9492, Frame 0246, or for which a copy thereof is attached.

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as shown below:

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[ ] Copies of assignments or other documents in the chain of title are attached.
[NOTE: A separate copy (*i.e.*, the original assignment document or a true copy of the original document) must be submitted to Assignment Division in accordance with 37 CFR Part 3, if the assignment is to be recorded in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

November 4, 2003
Date

Linda K. Russell
Typed or printed name

(713) 624-8956
Telephone number

Signature

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Applicant: K. Beers, et al By: JT
Serial No: 09/107,141 Serie No: 4572
Date Mailed: 8-25-03 Date Due: 9-17-03

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